POWER

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Keeping Up With the Job

THERE is nothing that is so disheartening and discouraging, so conducive to failure as a job that has got ahead of one.

In fact, continued inability to keep up spells failure, is failure and "nothing else but."

Difficulties pile up. The need for the stitch that was not taken in time leads to a rip. The leak that was not "got around to" results in a blow-out.

Jobs that would have been ordinary parts of the day's work magnify with neglect and become nightmares, inviting excuses for further delay.

The orderly progress of the work is interfered with and one becomes rattled in the struggle between things that must be done now and things that ought to have been done before.

Work that has been done is wasted because something else is not ready for its application. Time is lost and embarrassment and discredit incurred because parts have not been ordered or something got ready in time so that something else may be finished.

A careful budgeting of one's time, intelligent selection as between the more or less essentials, foresightedness and planning ahead and the strength of will to tackle the less attractive and more onerous job instead of the easier and more interesting one are some of the things that keep one up with one's work and make for easy sailing

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Power Plant Cost Accounting

MOST well-organized industrial power plants maintain records of power plant costs. Such cost accounts are usually subdivided so that operating and maintenance costs may be determined separately for fuel handling, boiler room and engine room. These accounts permit monthly and yearly comparisons with previous records, and allow the plant management to see at a glance whether the power plant is being as economically operated as when the equipment was new. This, however, does not show whether the power costs have been consistently high, as might be indicated if it were possible to compare the costs of one industrial power plant with those of another. The great variety of accounting methods and general lack of standardization makes of what might be a highly profitable procedure an impossible one.

The central station industry, on the other hand, has realized the value of cost comparisons, and, although hampered at the start because its accounting methods were prescribed by state regulatory commissions, it has gradually brought about a standard accounting form that has been adopted by the majority of these commissions.

A similar effort on the part of plant managements, perhaps acting through the engineering societies, might in time yield the same helpful results.

Wrong Application—the Manufacturer's Burden

MANY a good product has been wrongly applied. In all such cases the manufacturer suffers as much as the user. In fact, his loss may be even greater, since new business is affected along with repeat orders.

It may be argued that the manufacturer has done his part when he has furnished a good product at a fair price. The fact remains that he knows more about his own equipment than the average user, and can, at small cost, supply information without which the customer's misapplication will surely damage the maker's reputation.

Of all application faults, selection of a unit of wrong size or capacity is probably the most common. Undersized pumps, traps, motors, generator sets and boilers mean failure to carry peak loads. In such cases additional units must later be installed at far greater cost than that of adding capacity in the first place. Oversize machines, with wasted investment and low operating efficiency, are almost as bad. In the case of pumps or motors, the capacity may be correct for average or maximum conditions, but the machine characteristics—the relation of load, torque, speed, pressure and flow—are often entirely unsuited to the job. The same may apply to fans.

Bearings suitable for ordinary service are installed where abrasive dust will shorten their lives. Water and oil ruin motors not designed to meet severe service conditions.

And, finally, the machine may be rightly selected as to size, characteristics and construction and yet be located where lack of space or light will cause neglect. Maintenance is handicapped from the start.

As a simple matter of business good-sense the manufacturer cannot dodge the issue. For his own protection he must see that the equipment he sells is properly selected and correctly installed.

Load Building in the Industrial Plant

MUCH of the effort of central station electric companies is concentrated upon load building, which usually consists of inducing the individual customer to purchase more current. Sales of electrical appliances, such as irons, vacuum cleaners, refrigerators and washing machines, in the domestic field are vigorously pushed. The result is an improvement in comfort and convenience for the customer and in load for the producer.

Is it not possible for the engineer of an industrial plant to follow a somewhat similar course of load building? It is not recommended that anything be done to induce the industry to use power plant products in a wasteful manner; but there are many ways in which almost any factory can increase its power consumption and profit thereby.

Take for example the use of light. In Detroit there has been an active campaign under way for several years to better factory illumination. A recent survey shows that in many plants in that city the lighting consumes one-third of the current used. A survey of comparable Ohio plants shows that light there accounts for but one-seventh of the energy consumed. Evidently the activity in the Detroit area has caused a marked increase in the use of electricity, although even there more light could be used, with a corresponding improvement in production. In most factories lack of light is a definite handicap.

Consider another service that is helping to build the load for central stations—refrigeration. This can also be promoted with benefit by many industrial power plants. Few factories have adequately cooled drinking water readily available to all workers. This can easily be provided by small electrically operated automatic

605 v. 70 pt. 2

coolers. Plant cafeterias and lunchrooms also can make real economies by using electric refrigerators of suitable size in place of the somewhat sketchy refrigeration equipment now so often seen. A further use for refrigeration, confined, however, to special cases, lies in the improvement of production processes and working conditions that may be brought about by the use of air conditioning or other services employing cold.

It would be possible to extend the list of services by which the industrial power plant load can be built up to cover power uses, steam, compressed air, water and other power plant products. But these uses will readily occur to the power engineer who studies his own plant. And if he does make such a study he will undoubtedly find ways in which he can at the same time increase the load on his plant, better the conditions in or improve the economy of the factory and enhance his own position.

Babbling Brooks Are Sources of Revenue

IN THIS country's early development industrial centers grew up around water power, largely for two reasons. The river furnished power and easy transportation. The advent of the railroad and long-distance power transmission changed this, and now many other factors influence the location of industries. Climatic conditions, labor supply and the attitude of labor, the attitude of state governments toward industries, proximity of markets, sources of raw materials, tax rates, are all determining factors in attracting industries. In many cases these are of greater importance than cheap power.

The many industries that have and are locating in the southeastern states are not going there because of the cheap power alone. Other favorable conditions along with a reliable source of power have been the deciding factors.

Maine has recently decided to continue her policy of not allowing power developed from hydro sources to be transmitted out of the state. Water power will not attract industries within her border unless these resources can be combined with other requisites for industrial development.

Long-distance power transmission has made it possible to harness water power where there is no market and transmit it to where there is one. Water power, unlike other natural resources, does not diminish with use. It can be developed and transmitted to a distant market for any length of time. When a use is found for the power near the developments, it can then be turned to this purpose, and the amount of the resource is just as great as if allowed to remain undeveloped until the home market was available. During the time the home market has been in the making the developed water power will be a source of revenue. Undeveloped water power is comparable to a babbling brook flowing carelessly to the sea. Developed and transmitted to a market, it becomes a source of revenue.

A Revival of the Large Gas Engine

EVENTS during the last two years have given a fresh lease on life to the large gas engine. While builders of such machines for years led a precarious existence, the development of the Louisiana and Texas gas fields has filled shops long dormant.

Lines from Texas to Denver and Kansas City, and other lines, leading both North and East from the Monroe Louisiana field, have necessitated the purchase of scores of gas engine-driven compressors of a thousand horsepower capacity. These units, by raising the pipe line pressure, permit gas to be piped hundreds of miles. The activity in the West Virginia gas fields indicates many other installations in the future.

Just what influence these new gas fields will have upon the entire gas engine industry is problematical. If the gas is sold at too low a price, it will be economical to burn it under boilers; while a slightly higher price will make its use in gas engines the more logical. With proper coordination between gas marketers and users and the engine builders, there should be a decided demand for gas engines, to the advantage of all concerned. For example, along the four hundred-mile line from Louisiana to Atlanta, Ga., there are hundreds of plants where gas engines could be employed. As climatic conditions in the South will not disturb the balance between gas demand and supply, as happens so often in northern states, gas for industrial power purposes should be available the year around.

Every now and then, in the midst of the celebration of "Light's Golden Jubilee," comes an inquiry questioning Edison's claim to having invented the incandescent lamp. While it is true that several contemporaries, both at home and abroad, worked on this problem at about the same time, or perhaps a little earlier, their lamps were operative on low voltage only. *Power* has no desire revive this controversy, the discussions of which fill volumes in the records of patent suits fought at the time. It suffices to point out that the courts finally decided in Edison's favor. As a matter of fact, the incandescent lamp as we know it today is largely the development of the research laboratory of the General Electric Company. That Edison, through his pioneer work in the old Pearl Street generating station in New York, may be called the "father of the central station" cannot be contradicted.

* * * *

One of the most important sessions of the Third National Fuels Meeting, to be held in Philadelphia Oct. 7 to 10, will be that on smoke abatement. A whole day (Thursday) will be devoted to the subject, during which will be told how the problem has been handled successfully in Salt Lake City, Nashville and Knoxville. The discussion is expected to bring out much helpful information, as this session will be an experience meeting

Modern *High-Pressure* Plant Will *Save* Paper Mill $100,000 per year

By G. H. SUHS
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Rhinelander Paper Company
Rhinelander, Wis.

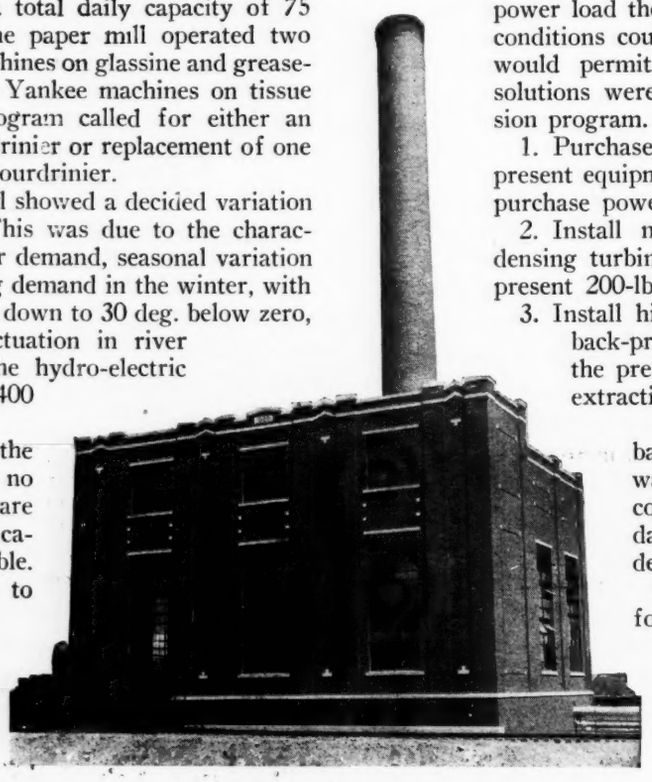
400-lb. boilers served by underfeed stokers and a 4,000-kw. double-extraction condensing turbine-generator are giving results that indicate a net saving of $100,000 a year compared with the former method of operation, which had necessitated buying part of the power. The turbine was installed six months after the high-pressure boilers, a comparison of performances with the new boilers supplying the old generating equipment, and later the new turbine, showing a saving in coal of 23 tons a day for the latter.

A DEFINITE expansion program brought to the Rhinelander Paper Company an immediate need for additional steam and power. The boiler room then in service might be classed as typical of the kind found in many of the older paper mills. It contained eight boilers having from 2,800 to 4,800 sq.ft. of steam-making surface. Five generated steam at 150 lb. gage pressure and three at 200 lb. pressure and 100 deg. superheat. Some of the boilers had been installed as early as 1903. Although the general layout had been modified from time to time as far as physical conditions permitted, the results were far from satisfactory. Steam costs were approximately 58c per 1,000 lb. and efficiencies ranged from 58 to 60 per cent. The 150-lb. boilers supplied the mill in general, and the 200-lb. boilers supplied steam to a 2,500-kw. single-extraction turbine. This unit, with a 2,400-kw. hydro-electric plant, supplied the electrical energy used.

The mill proper consisted of two divisions, the sulphite mill and the paper mill. The former operated four digesters with a total daily capacity of 75 tons of sulphite. The paper mill operated two Fourdrinier paper machines on glassine and grease-proof paper and two Yankee machines on tissue paper. The new program called for either an additional large Fourdrinier or replacement of one Yankee by a large Fourdrinier.

A study of mill load showed a decided variation in steam demand. This was due to the characteristic erratic digester demand, seasonal variation due to a heavy heating demand in the winter, with external temperatures down to 30 deg. below zero, and to the wide fluctuation in river flow, which varied the hydro-electric power from 2,400 to 400 kilowatts.

During the time of the heaviest loadings, no spare steam and no spare electrical generating capacity were available. Boilers were loaded to such an extent that any boiler trouble meant a partial mill shutdown.



An initial study showed an average mill demand with existing equipment to be: Total steam per 24 hr., 1,940,000 lb.; hourly electrical energy demand, 3,000 kw. It was estimated that the new paper machine would require 300,000 lb. steam per 24 hr., and that the hourly electrical energy demand would be 1,200 kw. This gave a total mill demand for steam of 2,240,000 lb. per 24 hr., and an hourly electrical energy demand totaling 4,200 kw. Of this power load the existing equipment under average conditions could supply all but 800 kw., but this would permit no spare units. Four possible solutions were considered for the power expansion program.

1. Purchase no new equipment, but operate the present equipment to the limit of its capacity and purchase power from a public utility.
2. Install new 200-lb. boilers and one condensing turbine and operate in parallel with the present 200-lb. equipment.
3. Install high-pressure boilers and use (a) a back-pressure turbine in conjunction with the present 2,000-kw. unit; (b) a double-extraction condensing turbine.

An estimated yearly operating cost based on 300 working days per year was computed for each plan. The costs were computed from actual data available, but a complete plant design was not made for each set-up.

Under Plan 1 actual steam costs for the existing plant were 58c. per 1,000 lb. Purchased power with the demand factor averaged 1.1c. per kilowatt-hour. The operating cost was figured to be $435,120, as shown in Table I-A.

Plan 2 called for steam with modern equipment in conjunction with a large part of the old equipment to be made at a cost not to exceed 42c. per 1,000 lb. Electrical energy on the same basis and condensing operation would not exceed 0.9c. per kilowatt-hour. On this basis the operating cost per year would be $334,080 as figured in Table I-B.

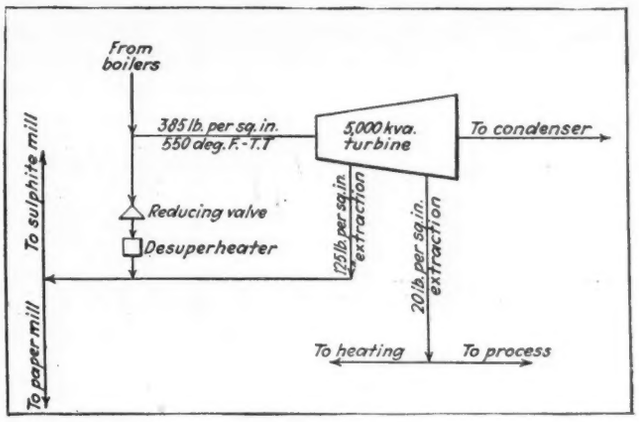
In considering, under plan No. 3, high-pressure boilers and turbines, it was decided at the time, 1927, that the design had not been stabilized sufficiently to warrant any pressure above 400 lb. in an industrial power plant.

Accordingly, various schemes were set up to deliver steam at 400 lb. initial pressure to a turbine. It was decided that all parts of the mill being supplied with 150-lb. steam could be served equally well with 125-lb. steam. The cooking process required a maximum of but 90 lb., and none of the reciprocating engines driving paper machines was using more than 100 lb. inlet pressure. The temperature of the 125-lb. steam could not exceed 400 deg. F., however, without causing trouble in existing equipment. Accordingly, initial superheat would be limited to such a point that the foregoing temperature would not be exceeded under normal load conditions.

There existed a demand for 20-lb. steam for heating, and some process. This could also be supplied by extraction from a turbine. Mill conditions showed a daily demand for 1,200,000 lb. of steam at 125 lb. pressure and 200,000 lb. of steam at 20 lb. pressure. The various turbine builders claimed from 60 to 63 per cent efficiency on their machines for converting available energy to mechanical energy. Based on these figures, the available power per day from the extracted steam would be a net gain, as the heat removed per pound of steam as mechanical energy would be less than 6 per cent of the total heat.

These data indicate average conditions. As a matter of fact, all demands varied greatly, as shown by the figures in Table II. Any combination of these limits might occur and it would be necessary to maintain good frequency and uniform extraction pressures while meeting them.

Installation of the complete new high-pressure boiler



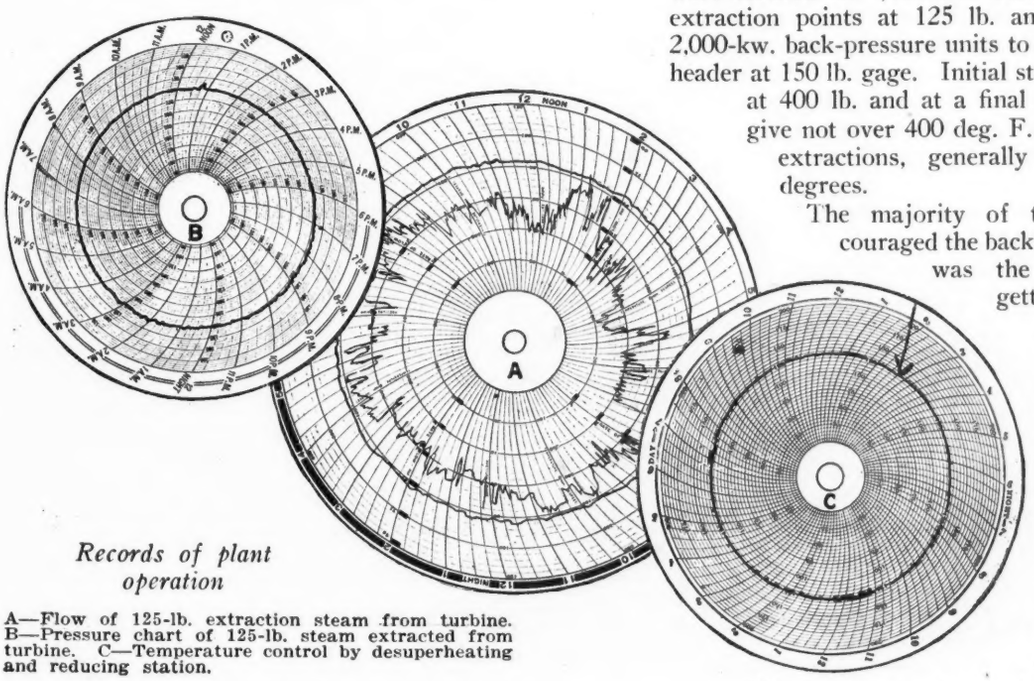
Steam-flow chart

room would preclude the necessity of operating any of the old equipment. Operating efficiency could well be held at 80 per cent. Assuming 13,500 B.t.u. coal costing $5.50 per ton and 125-deg. condensate from the mill heated by extracted steam to 235 deg. F., the fuel cost per 1,000 lb. of steam would be 28c. Available data indicated that a maximum charge of 15c. per 1,000 lb. of steam for labor, repairs and overhead would be conservative, giving 43c. per 1,000 lb. of steam as a fair cost. The 400-lb. operation would make a water rate of 13 lb. per kilowatt-hour, well within the normal operating range. The extraction operation, of course, would reduce the total steam generated by the amount of condensing operation it replaced.

This type of installation would reduce the total steam required to an average per day of 2,100,000 lb., and would dispense entirely with any purchase of power. The estimated yearly operating cost would be $270,000. On the basis of the costs estimated, it was felt that the plan employing the use of 400-lb. steam warranted being carried to completion.

With a maximum indicated steam turbine load of 3,400 kw., it was felt that a 4,000-kw. capacity would give sufficient reserve. Accordingly, performance data were secured on 4,000-kw. double-extraction units with extraction points at 125 lb. and 20 lb. gage, and on 2,000-kw. back-pressure units to exhaust into the present header at 150 lb. gage. Initial steam was to be generated at 400 lb. and at a final temperature that would give not over 400 deg. F. in the medium-pressure extractions, generally agreed upon as 550 degrees.

The majority of the manufacturers discouraged the back-pressure turbine. There was the possible difficulty of getting the governors on the two entirely independent machines to function properly when handling both steam flow and frequency. The 2,000-kw. unit on hand was a four-stage machine, and expanding from 150 lb. through the four stages would not give particularly high economy; nor was the governor very sensi-



Records of plant operation

A—Flow of 125-lb. extraction steam from turbine. B—Pressure chart of 125-lb. steam extracted from turbine. C—Temperature control by desuperheating and reducing station.

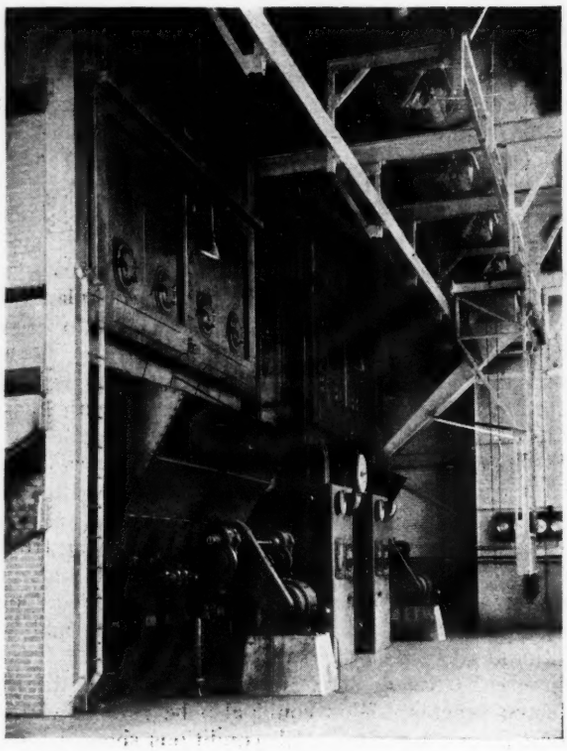
tive. The best combination obtainable showed that the operation of the new back-pressure machine and the existing unit would require about 3,000 lb. more steam per hour than would a double-extraction unit. It was definitely decided, therefore, to buy a double-extraction unit, "custom built to load conditions." Steam conditions at the throttle were to be 385 lb. gage and 550 deg. total temperature.

In the expansion program the original plan was to erect a boiler room first and operate at 200 lb. gage until such time as seemed best to proceed with the new turbine installation. But it was necessary to go through with the complete turbine details in order to determine the boiler room characteristics.

An estimated average steam load of 2,240,000 lb. would call for operation in the vicinity of 200 per cent rating by two 8,340-sq.ft. boilers, or 175 per cent average rating by three 6,000-sq.ft. units. The final decision was to install two 8,340-sq.ft. boilers, but design the boiler room for three units, permitting one spare. Under conditions of the best river flow, one boiler could carry the load at 300 to 325 per cent rating and permit inspection and normal maintenance on the second unit.

Both powdered coal burning and the use of stokers were considered. High-grade Eastern coal from the Great Lakes docks was chosen, as it could be purchased to a decided advantage. The particular section of the country in which this plant is located is subject to severe winters and heavy snowfall. This raised some question as to the advisability of using powdered coal, because of the possible difficulty in pulverizing it when wet.

To get first-hand information, several plants already operating on powdered coal were visited. Particular interest was directed to operation under winter conditions. Some plants reported a drop of as much as 40 per cent in capacity in the winter with wet coal; others had less trouble, particularly those installations using preheated air in the mill. With the heaviest steam load usually coming in the middle of the winter, a possible drop of 25 to 40 per cent in capacity under such conditions was not particularly appealing. The guaranteed operating efficiencies of both powdered coal and stokers were close. The final purchase was underfeed stokers, largely because of the fear of trouble in pulverizing with wet coal. The size selected makes it possible to obtain 400 per cent maximum rating on the boiler.



High-pressure boilers served by underfeed stokers

Water walls and clinker grinders were included with the stokers. In the side walls they are 42 in. high along the fuel bed and form the entire rear wall of the clinker pit. Economizers of the unit type and containing 60 per cent as much surface as the boiler were installed. Operating data for this equipment indicate final exit-gas temperatures of 365 deg. at 200 per cent rating with 240 deg. feed water. Manufacturers' guarantees on the combination of equipment which was installed were 86 per cent.

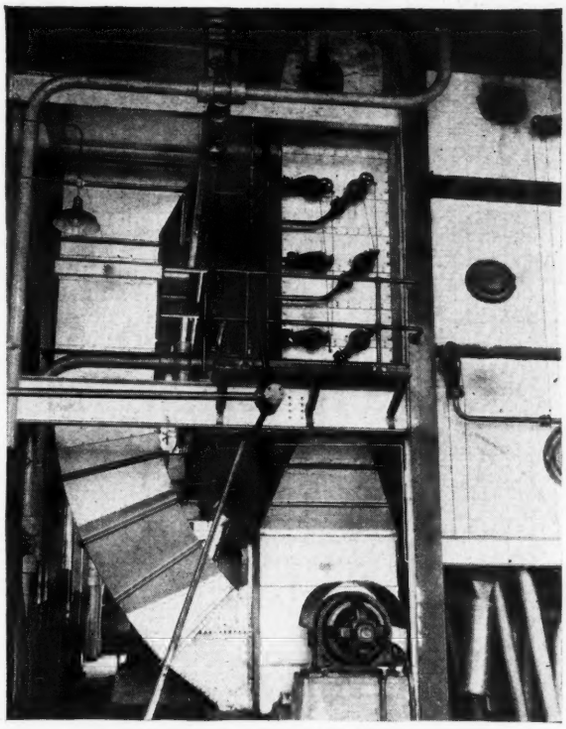
As the existing turbine called for 200-lb. steam with 100 deg. superheat, it was necessary to install a reducing and desuperheating station between the boilers and the 150-lb. header. Little data were available on desuperheating stations in general and some trouble was

Principal Equipment in the New Plant of the Rhinelander Paper Company

Boilers, two, Stirling, 8,340 sq.ft., 415 lb., Babcock & Wilcox Co.
Stokers, two, underfeed, 8-retort, 29-tuyere, clinker grinders, motor-driven ..... American Engineering Co.
Water walls, 25 sq.ft. per boiler .. American Engineering Co.
Superheaters, two convection type .. Babcock & Wilcox Co.
Economizers, two ..... Foster-Wheeler Corp.
Soot blowers ..... Diamond Power Specialty Co.
Pop safety valves ..... Consolidated-Ashcroft-Hancock Co.
Feed-water regulators ..... The Swartwout Company
Combustion control ..... Hagan Corp.
Coal conveyor, pivoted bucket ..... Link Belt Co.
Traveling weigh larry, 200 lb ..... Link Belt Co.
Boiler meters ..... Bailey Meter Co.
Boiler-feed pumps, two, 400 g.p.m., 475 lb., Worthington Pump & Mach. Corp.
Feed pump drives, 189-hp., 1,950 r.p.m. turbine; 200-hp., 1,800 r.p.m., 440-volt motor ..... General Electric Co.
Fans, forced draft, 41,600 c.f.m., 5.9 in. static pressure; induced draft, 59,600 c.f.m., 7-in. static pressure, Buffalo Forge Co.
Breeching and air ducts ..... Connery & Co.
Chimney, 11 ft. 6 in. x 200 ft., Alphons-Custodis Chimney Constr. Co.
Piping ..... Pittsburgh Piping & Equip. Co.
Desuperheater, 8 in., "S-C" temperature control . Elliott Co.
Reducing valve, 8-in ..... Locke Mfg. Co.
Globe and stop check valves .... Edward Valve & Mfg. Co.
Gate valves ..... Chapman Valve Mfg. Co.
Blowoff valves ..... Eckenroth Valve & Mfg. Co.
Turbine generator, 5,000 kva., 80 per cent power factor, 440 volts, 3 phase, 60 cycle; steam to throttle at 385 lb. and 550 deg. total temperature, Westinghouse Elec. & Mfg. Co.
Condenser, 4,000 sq.ft., and auxiliaries: Circulating pump, 4,900 g.p.m., 31.3 ft. head, driven by 50-hp. motor; air ejector, duplicate, 200 lb. steam, 28.5 in. vacuum; condensate pump, 110 g.p.m., 85-ft. head, driven by 7½-hp. motor; auxiliary pump supplying cooling water to generator air cooler, oil cooler and air ejector, 400 g.p.m., 15-hp. motor ..... Westinghouse Elec. & Mfg. Co.
General service motors ..... General Electric Co.
Generator panel, control and main breaker, General Electric Co.
General contractor, C. R. Meyers & Sons Co., of Oshkosh, Wis.

TABLE I—OPERATING COST FIGURES

A	
Steam cost (2,240,000 lb. per 24 hr.)	$389,760
Electric energy cost (800 kw. per hr.)	63,360
Total yearly cost	$453,120
B	
Steam cost (2,240,000 lb. per 24 hr.)	$282,240
Electric energy cost (800 kw. per hr.)	51,840
Total yearly cost	$334,080



Induced-draft fan, economizer and breeching

anticipated in its operation. The final layout called for a reducing valve with balanced piston valves having V-shaped ports, and a desuperheater of the direct-contact type with temperature control. Operating results from this combination were agreeably satisfactory, both as to pressure and to temperature over a wide range of steam flow. Accompanying charts indicate the results obtained when reducing from 200 lb. gage and 500 deg. temperature to 125 lb. and 400 deg. F.

About the first of the year the boiler room was placed in commission and was operated until June 1 at 200 lb. pressure. Operating costs for this period were satisfactory, as the reduction in steam costs indicated a yearly saving of $80,000 to $100,000.

At the time of writing, data are available for the first months of operation at high pressure. The usual adjustments have had to be made, but in spite of this the fuel reduction has been quite satisfactory. Actual fuel consumption per month for the first part of the year has been 3,375 tons, as compared with 2,685 tons with high-pressure operation, or a net fuel saving of 690 tons with the same mill loading.

TABLE II—VARIATION IN STEAM AND POWER DEMANDS

	Turbine Electric Energy, Kw.	125-lb. Steam, Lb. per Hr.	20-lb. Steam, Lb. per Hr.
Minimum	1,800	23,000	0
Maximum	3,400	57,000	16,000
Average	2,800	38,000	12,000

The foregoing saving is particularly interesting in that it covers results obtained with an identical boiler room operating at 200 lb. with a fairly modern turbine-generator and operating at 400 lb. with a modern extraction-type turbine-generator.

The engineering and design were carried out by the engineering department of the mill organization under the supervision of the writer. The construction work was done by C. R. Meyers & Sons Company, of Oshkosh, Wis.

N.E.L.A. Committee Attributes Prosperity to Cheap Power

ACCORDING to a serial report of the Water Power Development Committee of the N.E.L.A., which is now on the press, "a saving of a few dollars a year to the individual householder in cost of energy for domestic use through subsidizing that service at the expense of industrial users is not to be compared with the advantages of steady employment, regular wages and the consequent higher standard of living."

W. M. Carpenter, research statistician of the N.E.L.A., compiled the following table from data furnished by the Ottawa Bureau of Statistics.

COMPARISON OF GROWTH OF POWER AND BUSINESS IN ONTARIO AND QUEBEC
(Percentage increases, 1925 to 1927)

	Ontario Per Cent	Quebec Per Cent
Population	3.3	2.7
Electric Power:		
Main primary h.p.	23.9	6.0
Capital invested	31.7	10.3
Kilowatt-hours generated	61.3	28.2
Manufacturing:		
Capital invested	21.2	10.0
Employees	16.6	11.9
Salaries and wages	20.1	15.6
Value added by manufacture	26.5	17.2
Value added, per capita	22.5	14.1
Value added, per employee	8.5	4.8
Business and Wealth:		
Bank debits to individual accounts	49.2	30.3
Building permits in cities	65.8	33.4

In the opinion of the committee, sufficiently low industrial rates make it possible for large industries to be built up, producing abrasives, metal alloys, aluminum, bleaching materials, etc., at much lower cost than they could otherwise be produced.

"This is passed along to the ultimate consumer everywhere," continues the report, "when he purchases automobiles, kitchen utensils, cutlery, soap, newspapers, tools, etc. This low-cost energy is fundamental to the growth and expansion of that class of basic industry.

"In Canada are two examples of different ways of using cheap water power. For about fifteen years Ontario has been operating to favor the domestic consumer at the expense of the commercial and industrial user, whereas for about five or six years Quebec has followed a policy of using its cheap water powers to stimulate industrial growth. While the Quebec policy has not been in existence long enough to obtain full effect, it was thought that a comparison of the growth of industry in Quebec and Ontario might give some indication of the results obtained under the different policies."

REDUCING THE PRODUCTION OF POWER to terms of bituminous coal, the 1929 Commerce Year Book, which has just been published by the United States Department of Commerce, says: "The combined production of all mineral fuels and water power in this country is equivalent in its capacity to nearly 950,000,000 tons of bituminous coal annually, almost one half of the aggregate for the world. The United States produces more than two-fifths of the coal, about seven-tenths of the petroleum, and about one-third of the water power of the world. Our consumption of these sources of power and heat is the equivalent of 8 tons of coal per capita of the entire population, about 1.8 times as much as the United Kingdom, 2½ times as much as Germany, more than 3 times as much as France, and about 13 times as much as Japan."

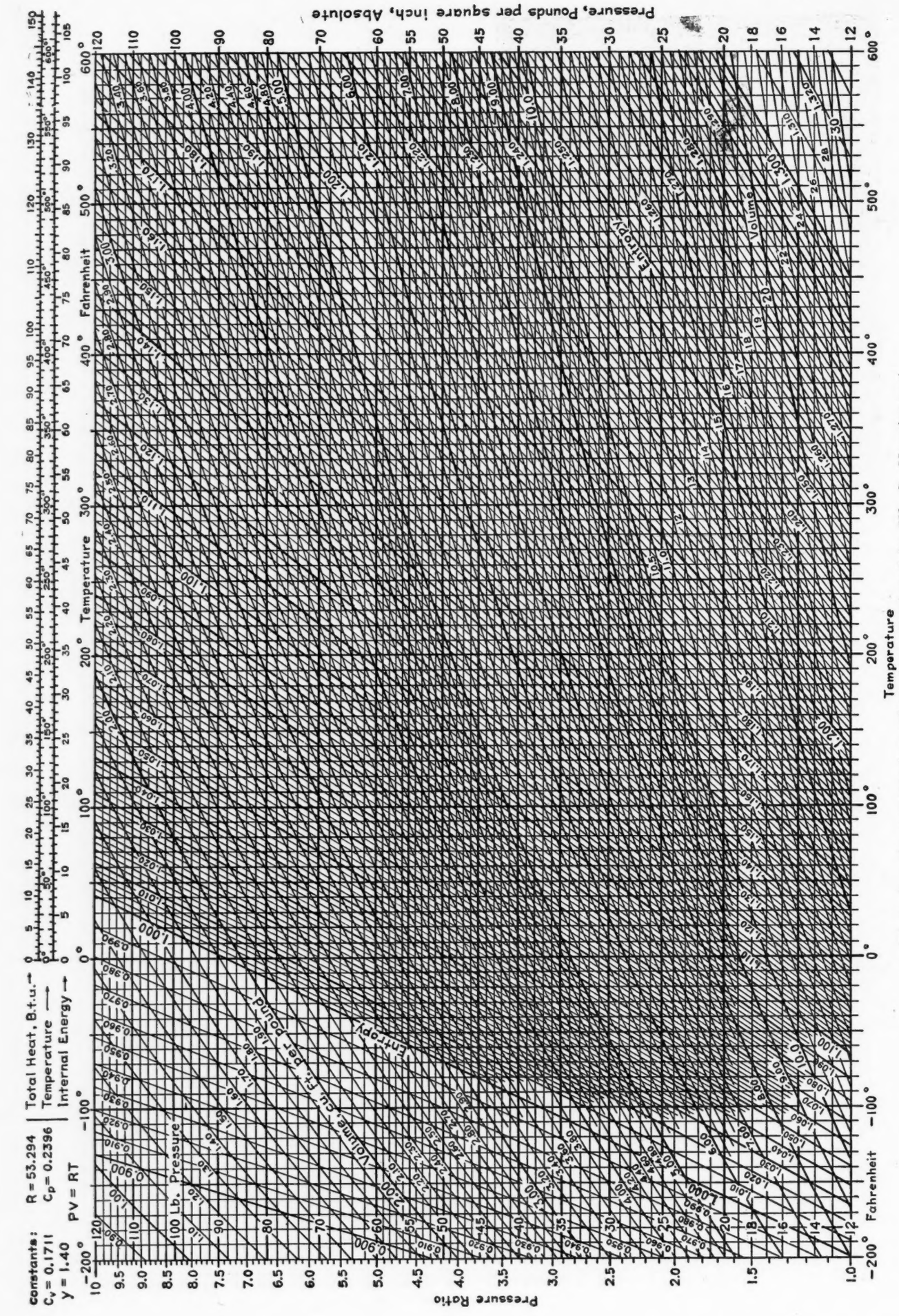


Chart for air compression calculations (designed by W. S. Huntington)

New AIR CHART Cuts Compression Calculations

By W. S. Huntington
Author of "Graphic Thermodynamics"

FOR THE solution of problems dealing with air compression and expansion, the chart given on the opposite page, and fully explained below, will prove a decided time-saver. It is so constructed that the quantities commonly involved in problems (pressure, temperature and entropy) are represented by straight lines, only those for unit volume being curved. This constitutes a considerable improvement over similar charts heretofore published.

The basic constants employed in the construction of the chart appear in the upper left hand corner. The fact that in dealing with air, both the total heat and the internal energy are proportional (for practical purposes) to the temperature, makes it possible to plot temperatures on the chart, and indicate the heat contents by means of the scale in the upper margin.

The air chart shown opposite has been drawn up to lessen the labor of air-compressor calculations. Its uses will be apparent to those familiar with the more common Mollier charts for steam. Pressure, temperature, entropy and unit volume can be read directly from the chart; total heat and internal energy are given on the upper scale. Several features, such as the pressure ratio scale, add to its usefulness. Instructions for the use of the chart are given in this article.

By combining the absolute pressure scale on the ordinate axis with a pressure-ratio scale, the range of the chart has been extended to cover the high pressures attained in multi-stage compression. An entropy value of 1.000 is assigned, arbitrarily, to the initial point on the chart, 12 lb. absolute pressure and 260 deg. absolute temperature (—199.6 deg. F.). Degrees Fahrenheit, absolute pressure in pounds per square inch and other corresponding English units are used throughout.

It is well known that when air is compressed or expanded adiabatically there is no change in its entropy value. If, therefore, starting with air at given conditions of temperature and pressure, we trace the line of entropy through that pressure-temperature point on the chart to the line for any other given pressure, we can there read the temperature which must exist at that pressure; or, conversely, we can find the pressure at which the air will reach a specified temperature as long as the change remains adiabatic.

Thus, for example, if the compression stroke begins on air which is at 13 lb. per sq.in.abs. and 90 deg. F., we read the charted entropy to be 1.1743. If the pressure at the end of the compression stroke is, let us say, 78 lb., we find that the 1.1743 entropy line cuts the 78 lb. pressure line at 458 deg. F. That is, if no heat was lost from the air in the course of the compression stroke, and no heat was received from friction or other outside sources, the temperature of such adiabatic compression would be 458 deg.

Again, assuming the same initial conditions, if the final pressure be 91 lb. per sq.in., the temperature will be 499.5 deg., and a temperature of 400 deg. would be attained when the pressure passed 62 lb. per square inch.

Volumes, in cubic feet per pound, may be read from the chart with a fair degree of accuracy. In the examples just given, the initial volume of air is read as 15.65 cu.ft. per lb. After compression to 78 lb. pressure and 458 deg. temperature, the volume was found to be 4.35 cu.ft. per lb. After the compression to 91 lb. per sq.in., the volume indicated is 3.90 cu.ft. per pound.

On the left-hand margin of the chart will be found the pressure-ratio scale. Its value is due to the fact that, starting with a given temperature, the final temperature to which this air may be brought by adiabatic compression depends upon the ratio of the final to the initial pressure, regardless of what the actual pressures may be. Thus, with air at 90 deg., if the ratio of the absolute pressures is 6, the final temperature will be 458 deg., whether or not the actual pressure values fall on the chart. On the ratio scale 1.0 is at the base line, 12 lb. per sq.in. abs., while the location of the ratio 3.0 is at 36 lb., ratio 7.0 at 84 lb., etc.

When one uses this scale the actual pressures are, for the moment, disregarded. For example, again starting at 90 deg., the entropy at unity ratio (the base line) is 1.1796, and tracing this entropy value to its intersection with the horizontal line for pressure ration 6.0, we find the temperature 458 deg., the same as found from the specific pressures 13 and 78 lb., which are in the same ratio. This is the final temperature after adiabatic compression from 15 to 90 lb., or from 20 to 120 lb., 60 to 360, 135 to 810, etc. Thus the chart can be used for pressures considerably beyond the absolute pressure scale as long as the corresponding temperatures are within the limits of the chart.

Volumes which correspond to pressures beyond the range of the absolute scale can also be found by use of the ratio scale, since the ratio of volume reduction, with adiabatic compression, is dependent upon the pressure ratio. This reduction ratio, or factor, is readily found for any practicable ratio of working pressures. For example, the unit volume at 90 deg., pressure ratio 1.0, is 17.0 cu.ft. per lb., while after adiabatic compression of a pressure ratio of 1 to 6, it is 4.73 cu.ft. The reduction factor, then, is $4.73 \div 17.0 = 0.278$.

While the volumes used in determining this factor are those for air at 12 and 72 lb., and at the stated temperature, the same ratio of volumes holds for any other pair of pressures that are in the ratio of 1 to 6, on any entropy line, with any initial temperature, whether it be

inside or outside of the pressure limits of the chart.

Suppose that one wishes to find from the chart the volume occupied by a pound of air at some high-pressure-temperature point, say at 378 lb. and 220 deg. Choose any convenient divisor, 7 for instance. One-seventh of 378 is 54, a pressure given on the chart. Then we find the entropy at 220 deg. and pressure ratio 7.0 (1.0968), and follow it down to ratio 1.0, at which the temperature is —70 deg. At these two points the charted volumes, are, respectively, 3.0 and 12.0 cu.ft. per lb. Hence the reduction factor we need is $3 \div 12 = 0.25$. Multiplying the volume at —70 deg. and 54 lb. (2.67 cu.ft. per lb.) by this factor, we have the required volume at 220 deg. and 378 lb., 0.666 cu.ft. per pound.

In the case of isothermal compression (temperature constant throughout) volumes vary inversely as the absolute pressures; that is, the reduction factor is the reciprocal of the pressure ratio. It may be observed that this fact affords a ready means of checking the accuracy of the volume lines at any place in the chart. For example, at 20 lb. per sq.in. and 100 deg., the charted volume is 10.35 cu.ft. per lb., and if this is compressed isothermally to 100 lb. per sq.in., it should occupy one-fifth of 10.35, or 2.07 cu.ft. per lb. With this the chart agrees.

The heat equivalent of the work done in adiabatic compression of air and in expelling it from the cylinder is measured by the total heat change that corresponds to the rise in temperature. In the first example used, where the temperature rose from 90 to 458 deg., the rise of 368 deg. corresponds to an expenditure of 88.3 B.t.u. of "total" heat, read from the scale. This work, measured in heat units, should, if converted, agree with that measured in foot-pound units by the area of an indicator diagram, provided the compression has been truly adiabatic.

For the case of isothermal compression the heat equivalent of the work done in compression and expulsion can be found by multiplying the absolute temperature by the change in entropy. For example, with compression from 14 to 70 lb. per sq.in. at 110 deg. constant temperature, the entropy decrease is $1.1775 - 1.0670 = 0.1105$. This value, multiplied by absolute temperature 569.9 deg., gives 62.9 B.t.u. per lb. of air.

The entropy difference 0.1105 should (within reasonable limits of error) be found anywhere in the chart, on any temperature vertical, for any other two pressures that are in the ratio of 1 to 5. It would likewise hold for pressures in that ratio which are not charted. There is a constant difference for any pressure ratio. Incidently, this affords a means for checking the accuracy of the entropy lines of the chart.

The "heat-work" diagram, a novel method of finding the heat-equivalent of the power rate without the use of an indicator diagram, will be explained by Mr. Huntington in an early number of *Power*. These diagrams are especially useful in studies of multi-stage air compressors. The air-chart on page 518 helps to make "heat-work" diagrams for air compressors easy to construct. Save it for Mr. Huntington's second article.

The Effect of Rating on Boiler Water Samples

By J. N. Evans
Brooklyn Edison Company

Tests here reported show how the concentration of solids in boiler water samples varies with boiler rating, location of sampling point and method of feed

WIDE variations in the concentration of solids in a boiler, as indicated by analyses of daily samples, is in many boiler rooms a source of great annoyance to the plant engineer. Some variation is, of course, to be expected, as the concentration of the different solids present is constantly changing in most boiler waters. Dissolved solids are usually being added in the feed water. Some of these solids may precipitate in the boiler as scale or sludge. Other solids may remain in solution gradually becoming more concentrated until later the concentration is reduced by blowdown. Solids are also being lost continuously from some boilers with the moisture in the steam, through boiler water leakage, or through deconcentrators.

But the changes possible from these causes do not explain the variations usually encountered, and sampling methods have frequently been blamed. Numerous theories have been advanced regarding the proper sampling of boiler water, but a comparatively small amount of actual test work has been possible to support them.

In an effort to obtain data on proper sampling methods all of the variables that tend to change the amount of solids in the boiler water were reduced to a minimum during recent tests on an 18,000-sq.ft., 425-lb. boiler. Makeup was supplied by evaporators, which were run at low capacity during the test to insure a pure product. The condensate tested practically 100 per cent pure as evidenced by a salinity recorder, which showed over 20,000 ohms resistance at all times. A recording thermometer on a throttling calorimeter showed that the boiler was delivering dry steam. The boiler drains were checked, and no leakage was found. In other words, no solids were being added and none was being removed from the boiler during the test except for solids contained in the samples drawn. The volume of the samples taken was less than 0.5 per cent of the boiler capacity; so this error was negligible.

Samples were taken from four different points. Sample point No. 1 was located in the middle downcomer header. Sample point No. 2 was located in a downcomer header a quarter way across the boiler, while sample point No. 3 was located in the end downcomer header. No. 4 sample point was the regular water column sampling cooling line at the same end of the boiler as No. 3 sample point.

Samples from points 1, 2 and 3 were taken directly from the downcomer sectional header, through a copper cooling coil immersed in ice water. Samples were drawn slowly, so that the water was cooled to about room temperature, eliminating the error caused by a hot sample. The samples taken from the column sampling line were taken in the customary manner, the column being thoroughly blown down through the cooling line and then the line filled with the sample. After this had

cooled for a half hour to a temperature of about 150 deg. it was withdrawn.

The test was run in the following manner: the boiler was up to pressure, but not steaming. Samples were taken from all sampling points. The boiler rating was then slowly increased to full rating within a period of three hours. Samples were taken from all sampling points at definite intervals during this period, and the boiler rating noted when each sample was taken. During this part of the test the boiler feed water was introduced at one end only. With the boiler at high rating the direction of feed was changed, the rating was slowly reduced to zero and sampling was continued.

The samples drawn were tested only for methyl orange alkalinity, the assumption being that the ratios of the different solids present in the water would remain constant regardless of the concentration.

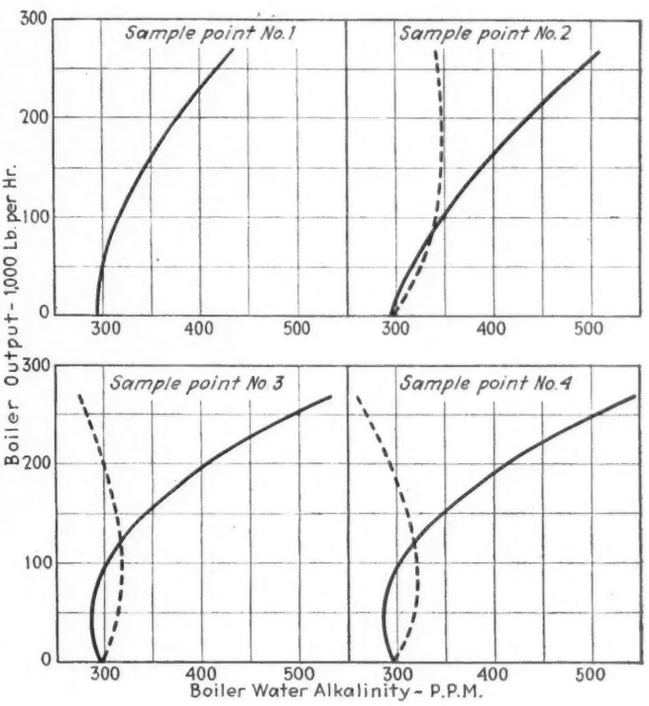
The curves show the results of this test. The solid lines show the concentration-rating characteristics when the boiler was fed from the end where Nos. 3 and 4 samples were taken. The broken lines show the values obtained with the feed from the other end. As might be expected, these curves coincide for sample point No. 1, which was located in the center of the boiler. The curves for sample point No. 2 are intermediate between the curve for sample point No. 1 and the curves of points 3 and 4. Curves 3 and 4 are practically identical, showing that the different methods of cooling produced similar results.

Another test showed that if the cooling period in the water column sampling line were extended from half an hour to two hours the concentration of the sample would be reduced approximately 50 per cent. This is explained by the fact that condensation is taking place at all times in the water column and gage glass, and this pure water tends to mix with and dilute the sample in the cooling line.

From the curves for points 2, 3 and 4 it will be seen that the feed is not evenly distributed over the length of the drum at different ratings. At low ratings it is evident that the feed leaves its distribution line shortly after it enters the drum. At somewhat higher ratings the feed distributes itself evenly, and at still higher ratings, probably due to the velocity of the flow in the distribution line, most of the water leaves the distribution line at the far end of the drum. The distribution line in the boiler tested was a four-inch line running the length of the drum, with half-inch feed holes every five inches along its length. If the boiler were fed from both ends of the drum, it is reasonable to assume that the rating-concentration curves for points 2, 3 and 4 would be an average of the two curves shown or similar to the curve for point No. 1.

The results of this test are supported by the following theories: With a banked boiler there is sufficient heat in the settings to cause a circulation of the water in the boiler. This would tend to give a uniform concentration throughout the boiler and water walls. This was demonstrated by the zero rating points from all four sampling points, which at the beginning and end of the test checked within 2 per cent. As the rating on the boiler is increased the volume of water below the water line in the boiler decreases, the remainder of the volume being occupied by steam. As the volume occupied by the water decreases the concentration must increase, as shown by curve 1 and the averages of curves 2, 3 and 4.

The concentration of the water remains constant down any downcomer until the water enters a heated tube. Here steam is produced and the water becomes more concentrated. This steam carries back with it to the drum some of the concentrated water. In the boiler tested all four water-cooled walls delivered their steam to the ends of the drum. The delivery tubes from the boiler entered the drum behind a vertical baffle extending several inches below the water line. The steam entered the main part of the drum around the end of this baffle and probably also carried some of the concentrated water. These conditions, combined with the uneven feeding, aggravated the concentration conditions at the end of the drum, as shown by curves 3 and 4. In conclusion, it was shown by this test that the concentration of boiler water in any part of a boiler is dependent upon rating and the direction of feed. By taking a sample from the particular curves apply only to boilers of the type tested, Samples then must be corrected for rating only, preferably to a banked boiler condition as standard. These particular curves apply only to boilers of the type tested. because each change in design will cause changes in circulation, with resultant changes in boiler water concentration, from any given sample point.



Curves showing how boiler water concentration varied with rating

Boiler water concentration in different parts of a boiler will vary between wide limits under different conditions. The modern boiler with water-cooled walls, and especially the sectional header type, will probably show greater variations than the older types of boilers. Unless the samples tested can be reduced to some standard conditions, the concentration values of the different solids will vary between wide limits under different operating conditions. This fact is appreciated by any one who has run daily samples on boiler waters. Since each boiler is different, a test similar to the one described above must be run to determine the sampling point with the fewest variables, and then a curve plotted to show the relation between concentration and rating. Only in this manner can boiler water concentrations be made comparable.

SELECTING SWITCHES

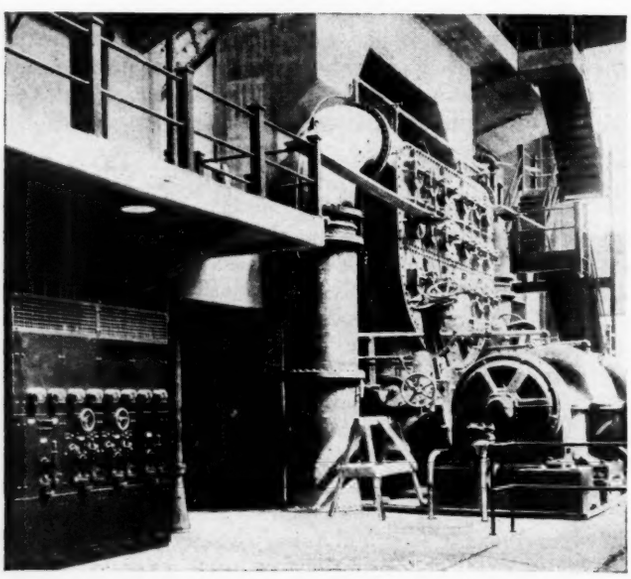
for Steam Plant Auxiliary Motors

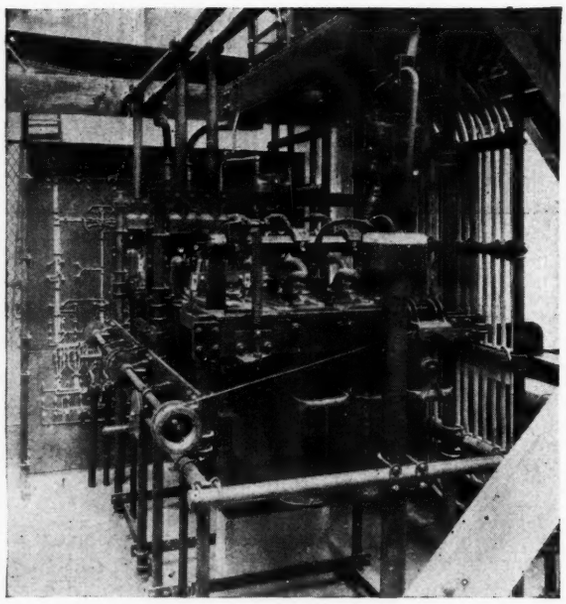
By B. G. Morris
Central Station Engineering Department
General Electric Company

Oil-immersed contactors compared with oil circuit breakers. The author's conclusion is that these two devices are not in competition as motor switches, but that each should be applied to the service to which it is found best fitted.

A GENERATING station's auxiliary drives are the means by which the ingredients used in power production are transported and controlled. Compared to the power these auxiliaries help to produce, the power they use is relatively small and the investment in them is correspondingly small compared to that in boilers, turbine-generators and condensers. Nevertheless, certain of these auxiliary drives, such as stokers, draft fans, boiler-feed pumps, condenser-circulating and condensate pumps, generator-ventilating fans, motor-driven exciters and others, must be maintained in continuous operation if the generating equipment is to carry normal load. It is this need for extreme reliability on the so-called essential auxiliary drives that has led to somewhat special practices in their switching and relaying.

Fig. 1—Condenser-pump motor and control





Oil-immersed contactor used as a primary switch on an induced-draft fan motor

Reliability of a high order requires simplicity, both of the motors and their control equipment. This naturally leads to the use of full-voltage-starting squirrel-cage motors wherever practicable. In modern stations motors as large as several hundred horsepower are thrown directly on the line when starting. Full-voltage starting does away with a certain amount of complication in the control equipment by eliminating the starting compensator. At the same time, by omitting the undervoltage release on the motor line switch, the switch remains closed during a voltage failure and the equipment will start automatically when voltage returns. This is desirable in many cases, because it minimizes the time of interruption and relieves the operators in times of stress, when their attention may be required elsewhere.

Although full-voltage-starting motors increase the reliability of auxiliary drives, they introduce other problems in the application of line switches for the motors. In modern plants the important auxiliaries, with few exceptions, are driven by alternating-current motors, and most of them are large enough to justify the use of 2,300 volts. The size of the motors will vary from 50 to 1,500 hp. To start large motors without an excessive drop in voltage requires a power supply of considerable capacity and which must not be loaded up with current-limiting reactors. Therefore, the possible short-circuit current will usually be high, 30,000 amp. not being unusual. In certain cases the older forms of industrial-type starting compensators, which were not inclosed in steel cases, proved to be a hazard to life and property, because they were not designed to withstand such currents. For modern power applications, switches of fairly

high interrupting and short-time current-carrying capacity are required.

The current a full-voltage-starting squirrel-cage motor will draw from the line at starting will vary from about 450 per cent to 1,000 per cent of the normal full-load current. This percentage will be greater for high-speed than for low-speed motors and will be greater for 25-cycle than for 60-cycle machines. The high reactance, line-start squirrel-cage motors are now coming into more general use. They have lower starting currents than the ordinary squirrel-cage machine. The starting current of such motors will usually be between 450 and 600 per cent.

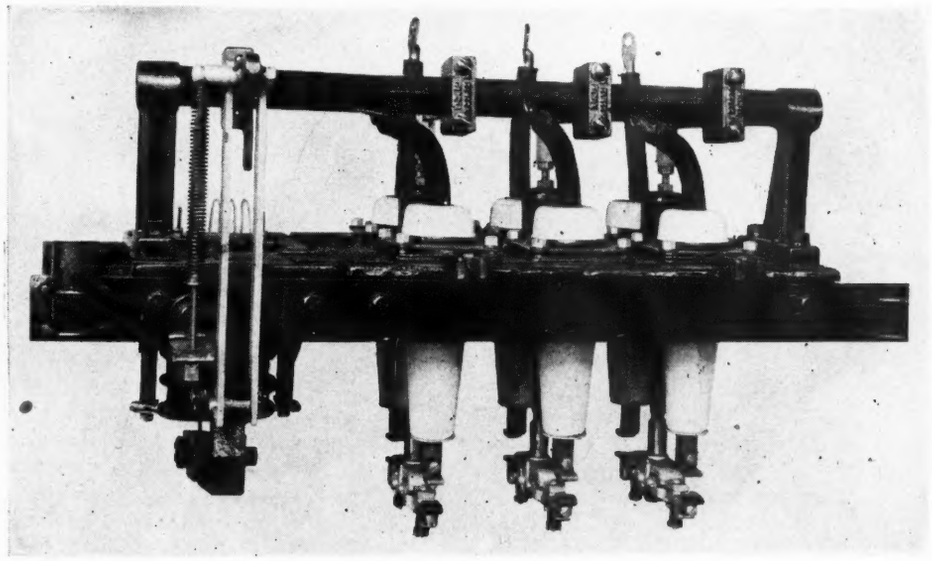
To handle these high-inrush currents imposes exceptionally severe service on breaker contacts. This is especially so if the breaker is manually operated, the closing speed being dependent on the operator. Added to the requirement of high interrupting ability there is the necessity of handling high-inrush currents without excessive maintenance.

The frequency of operation will vary with the type of plant and with the drive. On some drives the switches may be operated infrequently, as, for instance, on boiler-feed pumps and circulating pumps, which may remain in operation continuously for days at a time. On other drives, such as draft fans, the frequency of operation may be several times a day.

At the present time the choice of switches for motors driving the draft fans seems to present the greatest problem, because the service not only requires interrupting capacity and the ability to handle high starting currents but also may require more or less frequent operation. This has been brought about by a recent innovation in fan construction which is leading to the more general use of two-speed and three-speed squirrel-cage motors for draft-fan drives. Using this type of fan, as the load on the boiler varies, the motor connections may be changed from the high-speed to the low-speed winding, or vice versa. This introduces the possibility of more frequent operation of the switches. In applying switches to this service there is the choice of two types, the oil circuit breaker, Fig. 3, and the oil-immersed contactor Fig. 2.

The oil-immersed contactor has been applied almost entirely to industrial uses as a motor line switch. It is designed to handle any current taken by a motor under normal operating conditions. This includes, up to stalled motor current. It frequently does this with little maintenance. Oil-immersed contactors have an interrupting and short-time capacity in excess of ten times their rating, but their capacity in this respect is not as great as the oil circuit breaker. The contactor handles the starting current of squirrel-cage motors very well.

On the other hand, the oil circuit breaker, as its name implies, has been developed as a circuit switching and protective device, and this has required that it handle the circuit under the worst short-circuit conditions. To withstand such service it has been made heavier and more substantial than contactors, so inherently it is not as suitable for frequent operation, especially if its contacts must make from four to ten times the continuous rating of the switch. The service to which it has been applied has not required that it operate as frequently as the oil-immersed contactor.



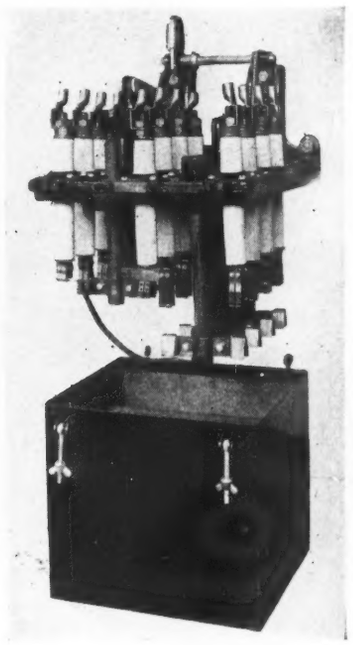


Fig. 2 (Above)—Three-pole oil-immersed contactor
Fig. 3 (Right)—Double-throw three-pole 4,500-volt oil switch

Logically, then, the contactor and the circuit breaker should not be considered as competitors, but each should be applied to the service for which it is best fitted. Motor-starting service on circuits where the possible short-circuit current is high seems to be an application requiring the good features of both types. More experience may result in improvements in both the contactor and the motor-starting breaker. Undoubtedly the design of oil-immersed contactors can be improved to increase their interrupting and short-time current carrying capacity, at the same time retaining their capacity for frequent operation. The oil circuit breaker appears to be satisfactory except for certain rather special applications where the inrush current is high and the breaker is operated several times a day. To meet these special cases minor modifications in breaker construction may be necessary to guard against excessive maintenance costs.

WHEELS

Ancient
Plodding
Picturesque

From Ewing Galloway, N. Y.

Overshot wheel turns the old grist mill

De Cou from Ewing Galloway, N. Y.

In Japan (Kyoto) the waterwheel on the roadside mill keeps old tradition alive in the midst of great hydro-electric developments

By Ewing Galloway, N. Y.

In ancient Syria, at Hamath, the waters of the Orontes are harnessed to great undershot waterwheels

Overhead on Idle Equipment Not a Part of Power Cost

By Walter N. Polakov*
Consulting Engineer, New York City

THE question what is to be done with overhead expenses accumulating on equipment serving no useful purpose (standing idle) is settled differently by various concerns.

Expense of idleness shall never be included in the cost of product, but must be considered as a business loss.

Power plant equipment is often in excess of the need, and if all fixed charges are piled on the output (power-steam) actually taken by the mill, the self-cost of the mill product may appear unfavorable.

The simple method outlined in the following standard practice will be found useful, if accuracy of cost finding is desired for close quotations in a competitive market.

Object: The object of the power house is to meet the demand of the factory for heat, light and power. The equipment is installed to perform its useful work. If equipment is not utilized, it represents an investment that does not serve useful purpose and merely requires expenses. It is important, therefore, to know what part of the equipment is utilized, to what extent, and if not, why not? Such knowledge leads to correct answers to the questions:

1. What equipment may be discarded?
2. What equipment must be added?
3. What it costs not to use the existing productive capacity.
4. How idle equipment increases cost of power and, therefore, of product.

Definition: All expenses incurred in connection with the ownership, and obligations involved, shall be met whether the equipment is used or not. If only part of the equipment is used, or if the equipment is used only part time, only a useful part of these fixed charges or expense of rent, etc., shall be charged against operation, while the other part forms the idle expense and is to be charged to the profit-and-loss account.

Determination of Fixed Expenses

The fixed expense of power plants is that portion of expense that is going on whether the plant is used or not. It consists of such items as interest on investment, depreciation, insurance, taxes, pro-rata of general supervision, etc.

For example: the value of a power plant is estimated as

Boiler plant	$35,090
Engine house	38,885
	$73,975

Assuming that fixed charges on this investment, its depreciation, insurance, supervision, etc., are 20 per cent annually, the power plant thus bears a burden of $14,800 a year.

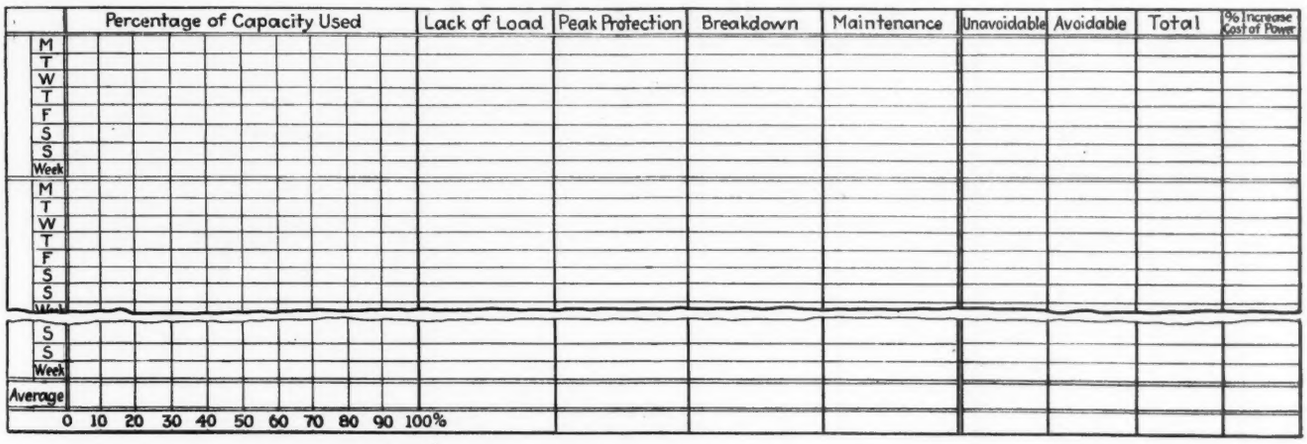


Chart for analyzing overhead charges

The capacity of this plant is 1,000 hp. and the normal operating time (105 hr. per week) is 5,460 hr., which means that the full normal output of steam per year is 175 million pounds. The overhead charge per thousand pounds of steam is, therefore, little less than 8.5 cents.

Now, if the operating expense (including upkeep) is, say, 40 cents per thousand pounds, the total cost is 48.5 cents if the factory makes a full demand on the power plant.

If, because of business depression, or poor salesmanship, or new business policy, or any other reason beyond the control of the chief engineer, the factory demand is only one-half of the power plant output, should the steam be priced at 40 + 8.5 + 8.5 = 57 cents, or 40 + 8.5 = 48.5 cents per one thousand pounds?

Obviously, the expense of owning the idle half of the plant is *not* due to the method of operating the boilers

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and engines, but *is* due to other business conditions. Therefore, in order to allocate these expenses correctly and not to adulterate the true cost of power, the overhead charges on the idle portion of the plant should be charged to the business profit-and-loss account.

The power cost sheet should carry only such amount of overhead as is found by the multiplication of a number of thousand pounds of steam generated during the period, times the charge per thousand pounds, which is, in the assumed case, 8.5 cents.

Stand-by: It is a good practice to keep idle a certain percentage of the boiler and turbine capacity in excess of the actual demand for maintenance work, repairs and protection. The proportion of protection ought to be determined, as well as a certain allowance that should be made for the peak protection. The charges for such stand-by protection as breakdown and peak protection are legitimate power charges.

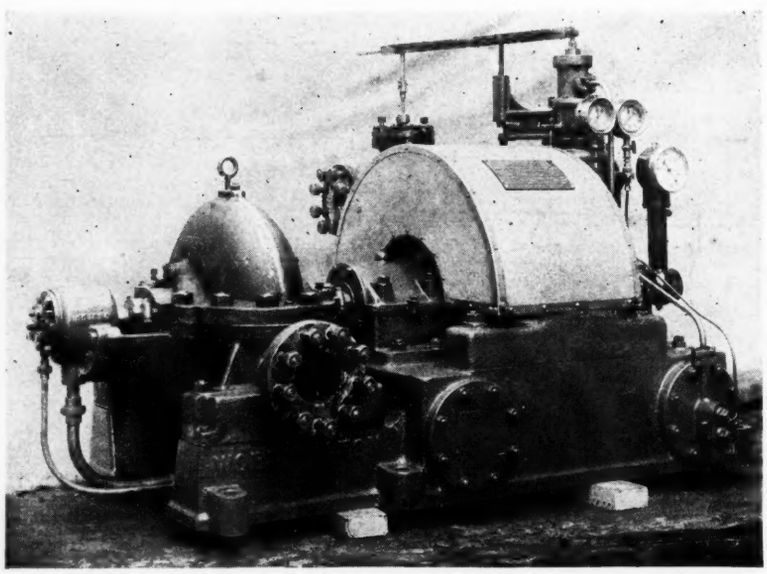
Idleness Charts: In order to keep track of the extent to which the power plant capacity is employed to satisfy the factory's demand, the distribution of fixed charges between idle expense and productive overhead should be made monthly and represented graphically on a chart form.

The percentage of the monthly actual steam output in pounds to the daily standard output should be represented on the chart by a straight horizontal bar drawn from the left end of the form under the percentage scale. The balance of the percentage scale is left blank to indicate the percentage of unused capacity. In the following columns to the right of the percentage scale should be shown in dollars and cents the distribution of idle expense as to the cause of same; such as lack of load (no orders), repair, etc. The total expense of idleness may be further analyzed in the general office and separated as "avoidable" or "unavoidable."

As far as the power plant is concerned, such causes of idleness as "breakdown" and "repair" are avoidable if they interfere with power production. Excessive capacity kept in unnecessary "reserve" is to be determined each time on its merits. On the other hand, idleness of power-generating capacity due to the "lack of load" caused by idleness in the mill is an "unavoidable" idleness so far as the power plant is concerned. Similarly, "peak protection" and "banking" items cause unavoidable idleness in the power plant, because the first is the result of uneven, unscheduled work in the mill and the second is an obviously necessary allowance.

Compilation and Distribution: These charts are compiled daily from the power plant log or other records. Every week the cost data are checked and blueprints or photostats of the chart made and sent to the general office and accounting department for proper entries and further guidance.

5,200 r.p.m.



FOUR hundred pounds water pressure is developed in a single stage by the small centrifugal pump impeller shown at the left. This is made possible by its high speed of 5,200 r.p.m. The complete pumping unit, two of which have been furnished from the Harrison works of the Worthington Pump Company for boiler feed service on the United States cruisers Pensacola and Salt Lake City, is shown at the right. The pump, designed to deliver 700 gal. per min. at 400-lb. pressure through a four-inch discharge opening, is driven by a two-wheel Terry turbine. The normal steam pressure on the turbines will be 285 lb. gage, with 10 lb. back pressure and no superheat. A low-speed oil governor is employed. As the pump has a flat characteristic curve it may be used on the boiler-feed service without the necessity of a pressure regulator. The turbine is fitted with hand controlled overload nozzles, so that the full capacity and pressure can be maintained with reduced steam pressure. Four of these high speed pumps are to be installed in each of the new cruisers.

How Operation of H. R. T. Boilers Was Improved and Smoke Eliminated

By Russell Melville

A RECENT article in *Power* regarding the efforts of the citizens of Knoxville, Tenn., to abate the smoke nuisance, brings to mind an experience that was interesting and also successful in proving that the methods used in securing these results were correct.

This particular plant contained three horizontal return-tubular boilers, two of 1,000 sq.ft. each, set in battery 24 in. above the grates, and having a steel stack common to both. The third boiler, with 1,750 sq.ft. of surface, had its own stack, and was set 28 in. above the grates. All were equipped with herringbone-type stationary grates.

At some time previous the bearer bars, at the bridge walls, had been raised, so that the rear ends of the grates were 4 in. higher than the deadplate. During the winter trouble was experienced in maintaining a sufficient supply of steam for a continuous process and heating load. Shutdowns were frequent, owing to faulty brickwork in the furnace walls, it being the custom to use all stretcher courses, with the result that the removal of large clinker formations usually brought the brickwork with it. A change in the personnel resulted in a series of gas and draft tests being made on all the boilers, the gas tests showing an average of 3.5 per cent CO_2.

At the end of the heating season the large boiler was cut out of service for repairs. The bridge wall was rebuilt and nine $1\frac{1}{2}$-in. air ducts leading from the ashpit were built into it. These air ducts were equipped with a damper operated from the front of the boiler. A V-pier, wing walls and bulkhead arch were built in the combustion chamber. The outer walls were gone over thoroughly, all cracks plugged, and three coats of cold water paint applied to the brickwork. Firebrick were cross piled in the clean-out door opening and plastered on the outside with a mixture of fireclay and cement. A damper was placed in the first course of the stack, with levers, pulleys and chains for operating from the front of the boiler, and a differential draft gage was attached.

Placing of extra brickwork in the combustion chamber retarded the velocity of the gases. Fortunately, the stack had ample capacity to overcome the resistance offered by the V-pier and wing wall construction.

On the lower end of the damper chain was attached a strip of sheet iron $\frac{1}{8}$ in. thick, 2 in. wide and long enough to extend from the open to the closed position of the damper, which had a series of drilled holes that made it possible to set the damper at any point between the open and closed position. It was found that the slightest variation in damper control had much to do with efficient operation.

After a number of experiments with various methods of firing, it was found that the coking method gave the best results, with very little smoke. At the firing period the damper was almost closed and, using a hoe, half of one side of the fire was shoved to the rear half and leveled. The fresh coal was then spread on the exposed grates to the deadplate, the depth of bed at the edge of the plate being four to five inches. The damper was then opened slowly to the full open position, held there for about one minute, and gradually closed to a predetermined opening as indicated by the draft gage, the load and the condition of the fire.

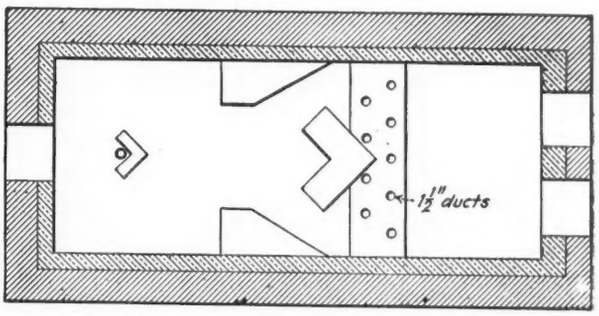
The damper was partly closed when cleaning fires, the good coke was winged to the opposite side of the grates, the clinker and ash removed, and fresh coal spread from the bridge wall to the deadplate; the coke was then winged back on top of the green coal. In eliminating smoke this method proved best.

A number of gas readings were taken daily. The average CO_2 was 13 to 14 per cent, with occasional readings of 15 and 16 per cent. The coal was passed through a crusher, elevated to overhead bins and delivered to the firing aisle through chutes. It had an ash content of from 7 to 10 per cent.

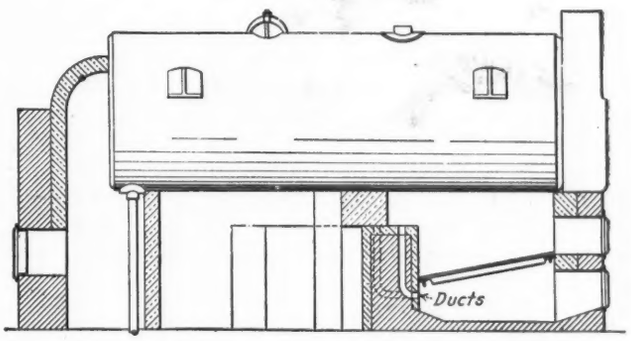
With the large boiler in service, the two smaller boilers were shut down, repairs were made to the bridge walls and the grates were lowered at the rear end. No V-pier, wing wall or duct construction was used. Dampers were placed in the Y connection of the breeching, and all cracks in the outer walls of the settings were calked with cotton waste saturated in fireclay liquid.

Tests made on these boilers, with the same methods of firing and damper control, were not as efficient either in smoke elimination or CO_2 readings; the best that could be had was 8 to 10 per cent.

From this and other experiences of a like character, the writer is fully convinced that the problem of smoke abatement, particularly in hand-fired boilers, lies in having a boiler setting absolutely tight against air infiltration, with either a high setting above the grates,



Plan and sectional elevation of setting that eliminated smoke



or interior brickwork construction in the form of V-pier, wing, curtain, or checker walls, so that the combustible gases can be thoroughly mixed with the combustion air. One of the most important factors in the effort to eliminate smoke and secure high efficiency is proper damper control. No one method will fit all hand-fired boiler plants. Load conditions and other factors will determine the best way in which worth-while results can be obtained.

Silencing The Big Noise

The problem of controlling noise has now become a special branch of engineering. For noise, and the atmospheric pulsations which accompany it, not only lowers the efficiency of the worker who must listen to it, and decreases property values in the neighborhood where it occurs, but, as pointed out, may become a real danger.

By Hiram Percy Maxim
President, Maxim Silencer Company

ONE of the serious engineering problems that confronts users of modern power plant equipment is noise. As Diesel engines become larger and come to be located in built-up districts, as larger and larger air compressors come to be installed, and as blow-off pressures of steam and air become higher and higher, noise intensities mount and grow intolerable. Means for controlling these major noises has become a special branch of engineering, and it is important that engineers know of the advances that have taken place along this line.

One of the most objectionable noises that is encountered today is that due to the exhaust of the larger Diesel engines. We have in this field engines developing as high as 3,750 hp. and exhaust pipes having diameters of the order of 36 in. The energy liberated by each exhaust puff generates noise which has in one case been heard at a distance of fourteen miles. It approaches the noise of artillery; is worse in one respect, since it persists steadily day and night.

Another noise which has required serious engineering consideration is that made by the suction of large air compressors. Here there are two objectionable consequences. Not only is the noise of a nature and a continuity that creates intolerable conditions, but inaudible pulsations, caused by the repeated waves of depression, produce highly dangerous vibrations in floors, walls and roofs. There are records where buildings housing air compressors have been threatened with collapse as a result of the vibrations set up by the periodic "holes" sucked in the atmosphere. A depression in atmospheric pressure of a fraction of an ounce per square inch, spread over a large area of a wall or a roof, and coming at a regular frequency, can amount to an oscillatory thrust of many hundreds of pounds. On a section of wall or roof 15 x 50 ft. a ½ ounce depression per square inch amounts to 3,375 lb. inward load.

Still another noise which has grown in intensity of late years is the roar made by high-pressure discharges, such as from steam safety valves, reliefs, etc. This roar carries long distances, and, since it usually bursts out suddenly, is intensely objectionable. There are also a multitude of minor noises, which every engineer has encountered.

Among the first to undertake the scientific control of big noises appears to have been the writer. The silencer was originally produced, of course, to handle the big noise of firearms. The difference between a gun barrel and an exhaust pipe is not great, as both are called upon to carry and liberate into the atmosphere high-pressure gases. In the case of the gun, provision must be made for the projectile, whereas in the exhaust pipe there is nothing but the discharging gas. However, while back pressure is of no moment in the gun, it is of prime importance in the exhaust. It is here that the engine silencer must depart from the gun silencer.

At the power plant of the Tucson Gas, Electric & Power Co. at Tucson, Ariz., there are two 3,750 hp. Diesel engines coupled direct to generators. The exhaust pipe of each engine is 32 in. in diameter. These two pipes lead outside of the building and into the intakes of two silencers. From the outlet end of each silencer a stack runs some twenty feet straight up for the final discharge into the atmosphere.

Before the silencers were installed the noise of one of these engines could be heard all over the city. With the silencers the noise was audible in the immediate vicinity of the plant only. The back pressure was not increased enough to affect the operation of the engines or the fuel consumption, nor over what it was with an open exhaust pipe. These silencers weigh 26,000 lb. each, and measure 7 ft. in diameter and 20 ft. in length. They are constructed of boiler plate ⅜ in. thick and are similar to boilers in general construction.

An example of noise combined with pulsation is an air compressor installation in one of the large automobile body factories in Detroit. In this plant there were two large compressors installed in a new reinforced concrete power house. The compressors made an extremely objectionable hollow, booming noise, and in addition created a vibration in the floor, walls and roof of the building that shook windows, doors and partitions and caused an alarming movement of the walls and roof. It indicated clearly the ultimate collapse of the building if it were allowed to continue. Two 14-in. silencers were installed on the intakes of these compressors and eliminated the noise and pulsation. This was accomplished without restricting the capacities of the compressors or increasing the power necessary to drive them.

A different kind of a noise, which required serious attention, came from the discharge of high-pressure steam safety valves during testing by the manufacturer. The steam pressure in this case was 1,200 lb. per square inch and the rate of discharge while blowing off was 60,000 lb. of steam per hour.

When one of these valves let go at the pressure mentioned, it made the neighborhood anything but a pleasant place in which to work or live. In subduing this noise, back pressure had to be given consideration, for the reason that any lifting of pressure on the discharge side of the valve altered the blowoff point. A silencer was installed on the discharge of this valve-testing equipment, and the noise was rendered completely inoffensive. The back pressure was so low as to be negligible.

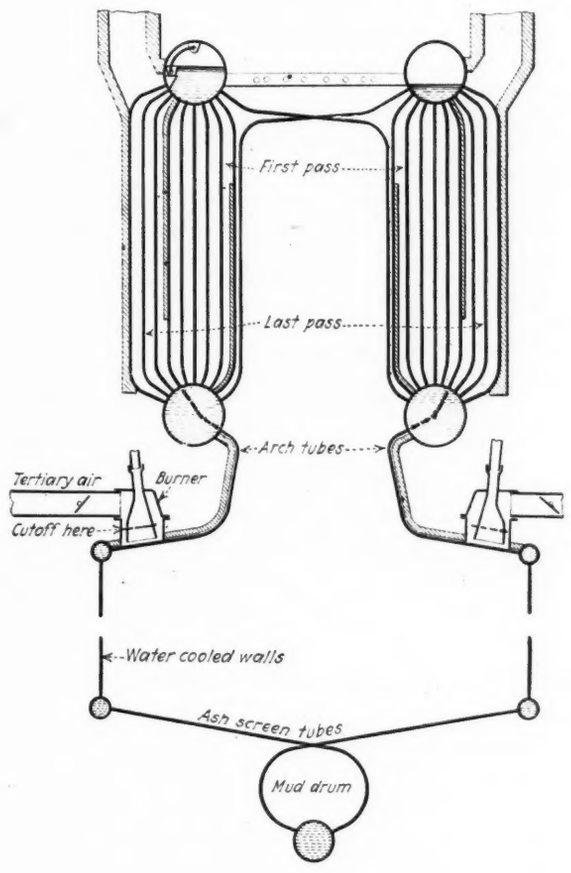
The largest positive pressure blower installations (which make a particularly objectionable throbbing noise), large fan blowers, vacuum pump discharges and, in fact, every form of pneumatic machinery that emits discharge noise can be rid of its unpleasant habits. Size, in short, is no longer any obstacle to securing quiet operation.

Right Out of the Plant

Experiences With a Large Boiler Operating at High Ratings

THE illustration shows a diagrammatic sketch of a double vertical water-tube boiler fired with pulverized coal. The boilers, of which there were a number of the same type in the plant, ran without slag trouble until a coal with a low fusing ash was tried. Then from 5 to 7 days was all they could be operated without removing the slag from between the tubes at the top of the first pass. This necessitated taking a boiler off the line and cooling it down sufficiently for the boiler gang to get inside the furnace and remove the slag with bars.

Removing the slag in this way took considerable time, and was expensive. Steam jets were tried between the tubes, but did not prove effective. Slagging bars of ¾-in. pipe, manipulated through the observation doors were more or less satisfactory. After a little practice the men could pick off the slag while the boiler was operating at a low rating, without taking it off the line, except for an occasional cleaning between the first and second pass. This operation, however, took considerable time and could be done only when the load was light.



Diagrammatic sketch of boiler

The water lance was next adopted. It consisted of a ¾-in. pipe, with an elbow bushed to ⅜ in., and a 6-in. nipple, the other end being connected by a hose to 50 lb. water pressure. With this lance two men could clean all the slag off the tubes in about twenty minutes.

Another unusual feature in the operation of these boilers was the fluctuation in the water level in the drums. Sometimes both whistles would blow at the same time, one for high water and one for low. Then the water would level up on both drums, and run that way for 3 or 4 hr., when it would change back to high on one drum and low on the other. The cause of this fluctuation was concluded to be a leaky baffle.

The rear baffle was made up of sheet steel, in sections, and bolted to the tubes. At first trouble was had from the plates warping at the joints and coming away from the drum, allowing the gas to bypass or short circuit to the stack. It appeared that when these baffles opened up, the hotter gas from the second pass tended to increase the evaporation in these tubes sufficiently to change the direction of circulation, the water going upward instead of downward, thus raising the level in that drum. At high ratings slag would build up and stop the leaks, but at low ratings it would cool off and drop away. Making the plates tight stopped the trouble.

Objectionable smoke was produced at high ratings when the boilers were first installed. It was found that the burners were too close to the arch tubes, which blocked the tertiary air. Several inches were cut off the end of the burners, as shown by the dotted lines. This ended the trouble.

THOMAS SHEEHAN.

New York City.

What Causes Air-Receiver Explosions

THE letter by C. O. Sandstrom in the Sept. 10 number of *Power* on the subject of "What Causes Air-Receiver Explosions," in my opinion, completely misses the point. Mr. Sandstrom says, "As the piston moves away from the discharge end of the cylinder, the air in the clearance space and the air leaking in through the discharge valve expands and does work against the receding piston."

This is true for a short portion of the stroke. Presently, however, the air in the cylinder expands down to atmospheric pressure and the inlet valves start to open. The re-expansion line on any air-compressor indicator diagram will show that the period during which the air is expanding and doing work on the piston lasts but a short time. As soon as the pressure in the cylinder drops to atmospheric and the inlet valves open, this period ceases. However, the discharge valve continues to leak and air passes from the discharge chamber, where the final pressure exists, to the interior of the cylinder, where atmospheric pressure exists. This leakage through the discharge valve makes a jet of air whose velocity is finally lost, so that the air which has leaked passes from the final pressure to atmospheric pressure in such a way that all of the energy represented by the expansion is dissipated in the form of heat, which heat is added to the leakage air itself.

The final result is that the air which has leaked through, after it reaches atmospheric pressure without doing work except on itself, will be at the same temperature at which it existed in the discharge cham-

ber. This is the high temperature resulting from adiabatic compression.

Another way of looking at the matter is as follows: Instead of the case of a leak from the discharge chamber to the interior of the cylinder, we will consider what would happen with a small but carefully formed nozzle. The air passing through this nozzle from high pressure to low pressure will acquire a high velocity. While in the low-pressure region and while having this high velocity the jet of air is at the low temperature consequent upon theoretical adiabatic expansion. The energy represented by this velocity is lost, however, in eddies and appears as heat which is added to the air jet. The energy corresponding to this heat exactly equals the work of adiabatic expansion, so that the temperature which existed in the high-pressure region is restored. This is but an example of a principle which is manifested in many ways, that a perfect gas when passing from a high to a low pressure without doing any external work (due to the fact that any work which is done is immediately turned into heat and added to the gas) remains at constant temperature. Expansion of this kind is sometimes called "throttled expansion," or "expansion with constant total heat."

Joule made an experiment years ago which physically demonstrated the validity of this principle. He had two closed vessels connected with each other with an opening closed by a valve. Air at a high pressure was in one vessel into the low-pressure vessel and made a jet which perature in each vessel being the same. The valve was then opened. The air rushed from the high-pressure vessel into the low-pressure vessel and make a jet which undoubtedly had appreciable velocity. However, the energy due to this jet was dissipated into eddies and friction, and was added as heat to the air. The temperature was carefully measured after the mixing and found to be identical with the initial temperature.

This occurrence is only true, however, for a perfect gas. If a gas is imperfect, there will be a slight cooling after the passage from the high to the low pressure, and no net work will be done. When air, or, in fact, any usual gas in a cylinder at a high pressure, say 2,000 lb., passes through a reducing valve to atmospheric pressure in such a way that there is no final velocity of the jet, there is an appreciable amount of cooling, and frost will form around the reducing valve. This fact is the basis of most machines for liquification of air and other gases. This cooling is due to imperfection of the gas. It becomes appreciable only when there is a large pressure drop. Air is so nearly a perfect gas that when it passes from, say, 150 lb. to atmosphere without doing work, it will remain at constant temperature within a small amount.

To return to our air-compressor cylinder, the air which leaks through the discharge valve has become hot and heats up the air in the cylinder which entered from atmosphere, so that the mixture of leakage air and air entering the inlet valve from atmosphere is at a temperature above the atmospheric temperature. This hot air is compressed adiabatically, gets hotter still and passes into the discharge chamber. Some of this hot air leaks back without doing work except upon itself and retains its maximum temperature for the reasons already explained. The mixture of this air with another lot of atmospheric air gives a new higher temperature, which is further increased by adiabatic compression. This process continues indefinitely until a stationary condition is reached for which the discharge air is very hot.

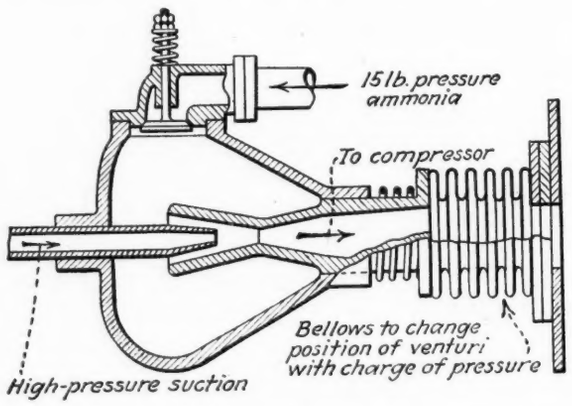
As Mr. Sandstrom states, this often gives a hot discharge pipe. There is no reason for introduction of any spontaneous combustion or catalytic effects. The matter is completely explained by the well-known thermodynamics of a perfect gas. This, of course, only explains the high temperature. No explosion can exist unless there is excess lubricating oil, as Mr. Sandstrom points out. Some of the frequent red hot discharge pipes from an air compressor are possibly due to slow burning of a deposit of lubricating oil in the pipe, the oil having become ignited by the high temperature caused by leaky discharge valves.

SANFORD A. MOSS,
Thomson Research Laboratory,
West Lynn, Mass. General Electric Company.

Multiple-Effect Compression

THE venturi compressor suggested by Edward Mahon in the Sept. 3 number of *Power* and reproduced herewith would not, in my opinion, reduce the power consumption or increase the capacity in a properly designed multiple-effect machine except in rare instances. In cases where the amount of high-pressure gas coming to a machine is great enough in proportion to the low-pressure gas, that is, where on every stroke the cylinder is filled with gas at full high suction pressure, it is difficult to see how the venturi compressor will improve conditions. Driving the low-pressure gas into the cylinder by the venturi method through the high-pressure ports will result in an actual reduction of high suction pressure, as the high-pressure gas must expand to compress the low-pressure gas.

The problem is quite different from that of applying the venturi compressor to air or steam. Mr. Mahon mentions a saving of high-pressure vapor, but it seems


15 lb. pressure ammonia
To compressor
Bellows to change position of venturi with charge of pressure
High-pressure suction

Compressor suggested by Mr. Mahon

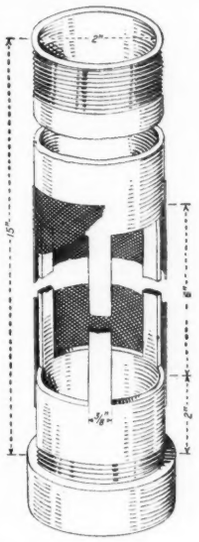
that with any given amount of refrigeration to be effected in coolers and storage rooms, the ideal condition to strive for is cooling by merely expanding the ammonia down to the highest suction pressure. With varying room temperatures a compromise must of course be made, endeavoring to handle as much high-pressure gas and as little low-pressure gas as possible without increasing the total amount of gas. However, if there should be an unavoidable increase in the amount of low-pressure gas to be handled, that is, beyond the capacity of the machine when running at maximum speed, the venturi compressor may be desirable, but will not be as efficient as the addition of another compressor to the plant.

Springfield, Mass. A. F. SHEEHAN.

An Improvised Oil Strainer

THE improvised strainer illustrated was attached to the inflowing oil line on the base of a high-speed vertical steam engine, the oil level being maintained by an overflow at the proper height on the opposite side of the base. The strainer was made of sufficient area to obviate frequent removals for cleaning.

A piece of pipe about 15 in. long was marked by a center punch, outlining the three apertures as shown. These were cut with a hack saw and the edges smoothed with a file. A piece of 40-mesh copper screening, 1 in. wider than the opening in the pipe and $\frac{3}{4}$ in. longer than the circumference, was wrapped around a piece of wood whose diameter was equal to that of the pipe. This allowed a $\frac{3}{8}$-in. lap, which was soldered. Then the copper cylinder was slipped off the wood and onto the pipe and clamped in place. A pipe cap on the bottom and the section of pipe between it and the screen served to catch any dirt that might be in the oil.



Detail of strainer

Kingston, Ont. T. J. DONNELLY.

A Practical Cost System for Industrial Power Plants

AFTER reading the article in the Sept. 10 number of *Power* entitled "A Practical Cost System for Industrial Power Plants," one is moved to inquire into some of the points mentioned.

There is no disputing the facts that these costs are necessary and that most operating engineers wish to understand the subject so that they can definitely state what it is costing the company for every pound of steam or kilowatt-hour of electricity delivered for manufacturing purposes. The matter, however desirous one may be of understanding it, is unusually complicated and it might be said that certain figures are even elusive in being brought to light.

The plants mentioned in the article are of considerable size and, naturally, there is a large enough operating and accounting force to gather in all of the data on the different report blanks. Suppose the operators of a plant around 500 hp. wish to use the forms submitted, it would seem as if they are going to have difficulty in obtaining some of the necessary amounts called for.

The sheet for "Expense Analysis" appears to be well arranged and thought out, but when we get to the part labeled total credits, such as steam to the different departments, etc., these amounts are more difficult of determination. What would interest many engineers is the method of computing the correct amount of steam used.

I suppose that the answer in this case is that steam-flow meters are used. However, if the demands for steam are fluctuating widely, can any flow meter be depended upon? This argument is frequently advanced by men of experience in the power plant field. If such meters are not thoroughly dependable, how are such reports accurate? It is generally understood that steam for dye vats, kiers, etc., is flowing at various rates. There are no returns to be measured; therefore, it would be interesting to know of some indisputable method of calibrating these various supplies.

Later we read in the form for the "Engineer's Report" under the heading for total steam deduction the steam used for blow down, pumps and soot blowers. Again, it is probable that the plant in question has been able to provide instruments to record all of this, but the article does not say so. These things may be obvious to them, but they are not to many operating engineers.

An article of this sort would be much more enlightening if the authors would explain how they can obtain, with a fair degree of accuracy, the amounts of steam used in soot blowing, for example. In most of the medium-sized plants, it is difficult to get approval of the expenditures necessary to obtain expensive instruments, and in many factories the methods of allocating the power and steam costs to the various branches of manufacturing are ineffective and inaccurate in the extreme. What many engineers wish, if there is a possibility of so doing, is a reasonably accurate method that may be used as a basis for computing the expenses of their departments.

The electrical side of power distribution is now well taken care of by instruments that are quite accurate, but the correct measurement of the fluctuating flow of gases and liquids is still rather undeveloped.

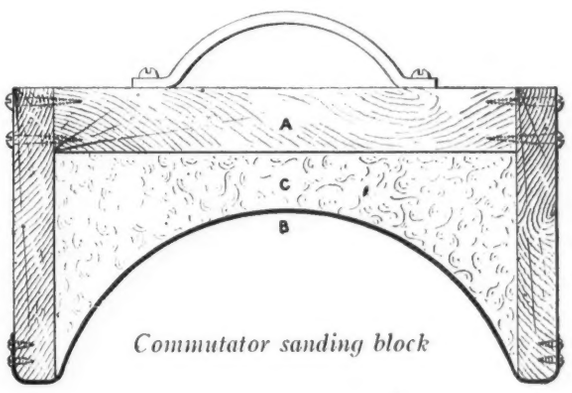
Cambridge, Mass. G. H. KIMBALL.

An Improved Commutator Sanding Block

THE ordinary form of commutator sanding block can be used on one size of commutator only, and even with a correctly shaped block the glass paper does not bear over the entire surface.

An improved sanding block suitable for several sizes of commutators can be made as shown in the sketch. It consists of a holder formed of three stout pieces of wood, as at *A*, a glass paper strip *B* being fixed over the open end of the holder and connected to the two uprights.

The strip *B* is thus left free to adjust itself to the curvature of the commutator. To make a cushion for the strip the space *C* is filled with cotton wool, just sufficient to provide a backing for the glass paper.



Commutator sanding block

Brentford, England. W. E. WARNER.

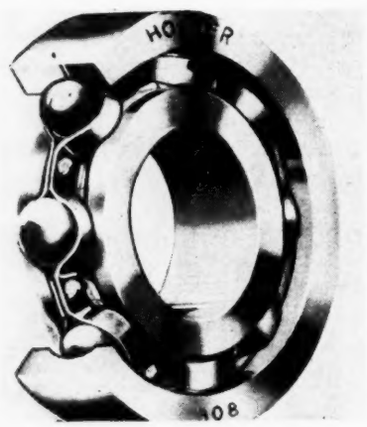
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Single-Row Annular Ball Bearings

DEEP-GROOVE no-notch construction to withstand heavy thrust and radial loads at high speeds is a feature of the line of single-row annular ball bearings introduced in standard sizes by the Hoover Steel Ball Company, Ann Arbor, Mich. Both the raceway and the balls are made of high-carbon chrome alloy steel, and the retainer is of riveted deep drawing steel.

The bearings are available in three series, light, medium and heavy, ranging for the lighter series from



Cut-away view of bearing

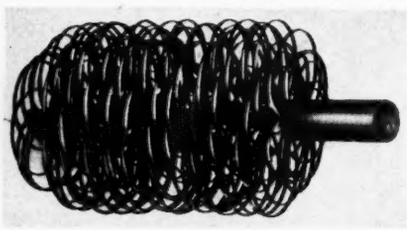
0.3937 in. to 4.7244 in. bore and for the heavy series from 0.6693 to 3.9370 in. bore.

New Tube- and Flue-Cleaning Brush

IN THE tube-cleaning brush illustrated the brush is composed of a number of eccentrically wound large spirals of tempered high-carbon steel flat wire having square corners.

The axes of the wire circles thus formed are parallel to the central support. Each spiral passes through the support and is firmly secured at that point. As shown in the illustration, the spirals are grouped around the support to make up a brush to conform to the shape of a tube.

When the brush is pushed into the tube or flue, the forward pressure causes the outer edges of the flat wires to tilt until their square edges press against the inner surface with a powerful scraping action. This action, it is claimed, is independent



Tube-cleaning brush of eccentrically wound spirals

whether the brush is rotated or pushed straight forward by hand, or rotated by a flexible shaft.

The brush illustrated is intended for cleaning scale from boiler tubes, or for any other uses where a flexible rotary shaft is employed. It is put out by the Specialty Manufacturing Company, 10698 Berea Road, Cleveland, Ohio.

Large Capacity Combination Gas and Oil Burner

THE combination entrained-combustion gas burner illustrated is a recent addition to the line of gas and oil burners put out by the Lee B. Mettler Company, 406 S. Main St., Los Angeles, Calif.

This burner, which is designated No. 42, is designed to operate under a range of gas pressure from $\frac{1}{16}$ in. W. G. to 20 lb. It has a wide range of ratings, as follows: $\frac{1}{16}$ in. W. G., 1,050 cu.ft. of natural gas per hour; at 3 oz. pressure, 6,700 cu.ft.; at 6 oz., 10,300 cu.ft.; and at 10 oz. pressure, 13,400 cu.ft. of gas per hour. The size of the gas inlet is 3 in., and the over-all dimensions are $17\frac{3}{4}$ x 34 inches.

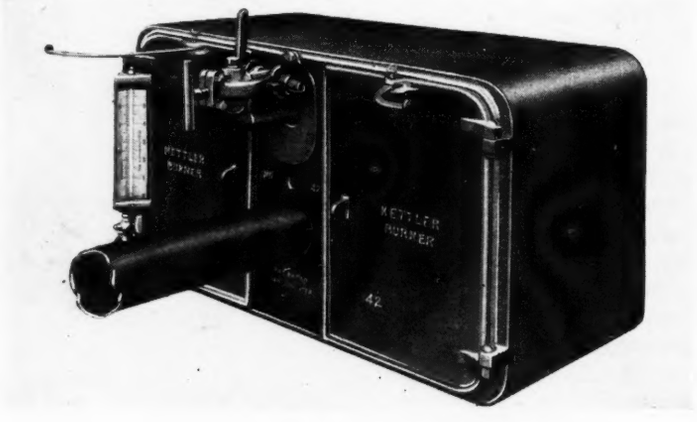
The new burner is similar in design to the former types put out by this company. It consists essentially of three parts, a cast-iron housing, a cast-iron manifold fitted with a series of orifices and a refractory mixing block. The gas manifold has a series of openings (in this case 42), into each of which four nozzles are fitted at an angle of 45 deg. With this construction four streams of gas meet at a central point in the mixing tube and by the impingement of one against the other cause violent agitation of the gas in a core of entrained air. The inner side of the manifold carries a refractory mixing block.

When burning gas or oil, all the air necessary for complete combustion passes through the apertures of the manifold and mixing block, the critical points of the mixture taking place as it leaves the orifice.

A mechanical oil burner is fitted in the center top opening, permitting the use of either fuel without any changes in the burner proper.

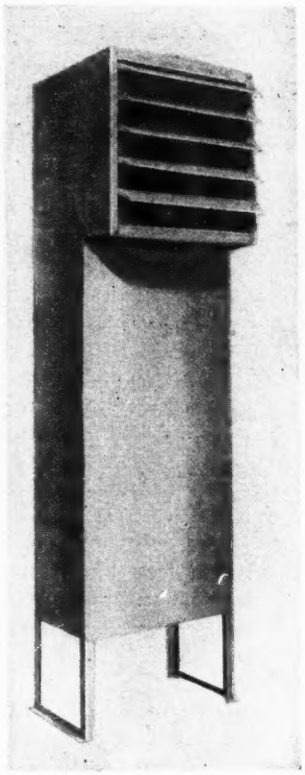
With the addition of this new unit, burners of 8, 16, 20, 32, 38 and 42 tubes are now available, giving a wide range of sizes and capacities.

Front view of burner assembly



Unit Heater in Recirculating Box

IN THE May 14 number of *Power* a type of unit heater suitable for combined heating and ventilating service, put out by the Young



Recirculating box for floor mounting

Radiator Company, Racine, Wis., was illustrated and described. In the accompanyng illustration is shown a heating unit of the type mentioned incorporated in a recirculating box designed for floor mounting.

This gives a flexible and convenient type of unit for a wide range of uses, as it can be placed in any location without further support. The heating sections consist of flat vertical copper tubes with brazed flat copper fins. The tubes are also brazed to the header plates. Thermostatic control can be provided when desired. The units are put out in four sizes to take care of a wide range of heating requirements.

Small Pipe Threader With Universal Guides

A NEW pipe threader, which incorporates, among other improved construction features, universal guides that automatically center the pipe, has been introduced by the Oster Manufacturing Company, Cleveland, Ohio. Other features of the new tool, which is designated the "Leader" and which threads and cuts pipe from 1 to 2 in., are new ratchet construction, floating stud and fully adjustable dies.

The threader is available in either of two types, No. 1, a plain tool without the ratchet device feature, and the No. 1A, with the ratchet construction. It is claimed by the manufacturer that because the ratchet is built directly around the dies where the strain of the pull ordinarily comes, much less effort is required to cut the thread, and that this also permits more freedom of action when working close to a wall or in other cramped quarters. On the ratchet-

Improved ratchet pipe threader

type tool, the ratchet can be set for forward or reverse or can be locked for use as a plain tool, by a simple turn of a control wheel.

New Steel for Boiler Plates

"IZETT" is the name given to a new boiler steel now being manufactured in this country by the Central Alloy Steel Corporation, Massillon, Ohio, under license from Fried. Krupp A. G., Essen, Germany.

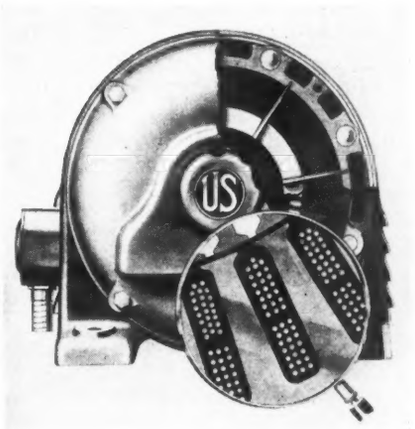
The outstanding property of the steel is the fact that it does not become brittle when cold worked. It is claimed to retain its toughness under all conditions encountered in boiler practice, and to be non-aging.

Motors With Asbestos-Insulated Windings

THE illustration shows the general construction and a magnified section of the asbestos-insulated winding employed in the line of motors put out by the United States Electrical Manufacturing Company, Los Angeles, Calif.

The important claim made for this form of insulation is that it does not carbonize and deteriorate under ordinary operating temperatures, as is usual with some forms of insulation. The method of applying it to the motor windings is, briefly, as follows:

The pure asbestos is first treated to render it moisture proof. Sheet asbestos is cut and shapel to conform with the shape of each stator slot. Die-cut shapes are made to fit between the coils and between phase windings where coil windings are nested. Separators are formed from thick asbestos plate board for insertion between coil sections of every slot. Then the winding is thoroughly impregnated with a heat-resisting compound known as "Asbestosite," a fine asbestos powder held in collodial solution by volatile diluents, which are driven off after the compound permeates the windings. By means of a special baking and curing process the asbestosite is made to harden and form a solid, intimately attached to, and isolating, the turns of the windings. This form of insulation is



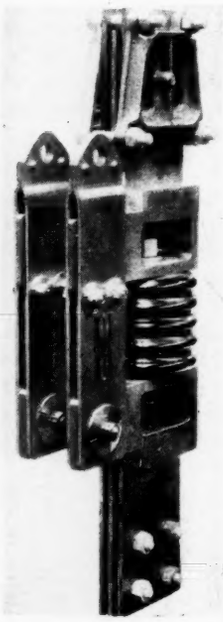
Motor and magnified section of winding

incombustible, eliminating the fire hazard from a breakdown in the insulation or short circuit in the winding.

Another feature of this line of motors, which is put out in ratings of $\frac{1}{4}$ to 125 hp., is the use of one-piece solid-construction die-cast aluminum rotors.

Double-Blade Tongue-Type Disconnecting Switch

DESIGNED for clamping directly on busbars, the double-blade tongue-type disconnecting switch illustrated affords a convenient



Switch assembly

method of inserting a disconnector between the oil switch and bus. The switch assembly forms a compact unit, with a clamp at the top to secure the upper contact of the switch to the busbar and a suitable extension on the lower contact for connection to the oil switch. This construction gives a high space factor and a short connection between the switch and busbar. The switch illustrated is put out by The Delta Star Electric Company, Chicago, Ill.

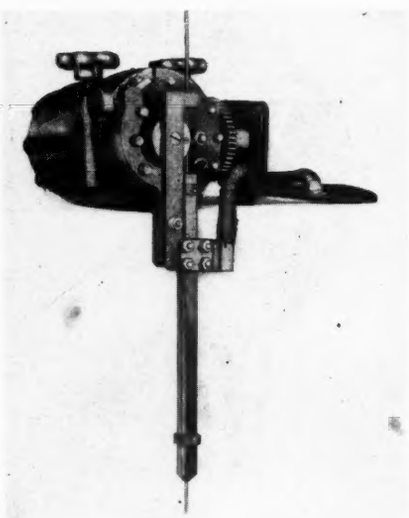
Improved Automatic Welding Outfit

AN IMPROVED automatic welding outfit designated the "Weldomatic," complete with electrode feeding device, control cabinet and operator's panel, is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. It is designed to operate from either a Westinghouse variable-voltage or a constant-voltage set.

The machine has been developed to meet the demand for an automatic welder of compact dimensions, and one that is equal in reliability to the usual shop tool. It automatically strikes and holds an arc between an electrode and the work to be welded without the operator being required to do other than press the starting button. The feeding device is of compact design, which permits its ready application to work-handling tools. The drive motor is mounted in a cylindrical frame which supports the nozzle assembly. The nozzle has adjustments for being moved in two planes, and it can easily be reversed to either a right- or left-hand type.

A new method of automatic arc control eliminates all clutches, relays, springs, etc. A rheostat controls the arc voltage, which is recorded on a voltmeter over a wide range. A switch on the panel also permits the operator to reverse the direction of the head motor to retract the electrode from the work under power.

Positive feed without slippage, extreme sensitivity insuring instantaneous response to arc voltage conditions, wide range of speeds, com-



Welder head, showing electrode feeding device

pact mounting dimensions combined with light weight, simplicity of design, ease of adjustment and smoothness of operation are some of the important features of the machine.

Liquid Packing for Gaskets and Pipe Threads

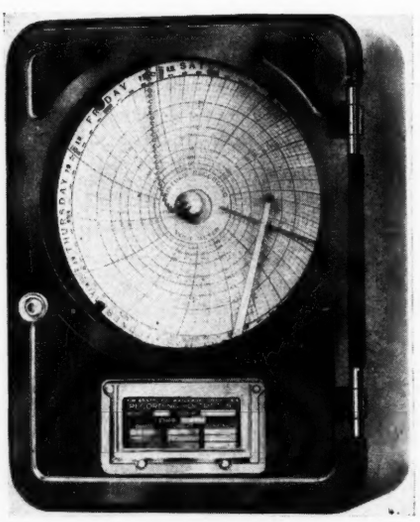
A TYPE of liquid filler or cement known as "Osotite," claimed to have strong adhesive power, assuring tightness in screw connections and gasket joints, is being put out by W. S. Anthony, 11-19 Moore St., New York City.

The material resembles black varnish in texture and color and is readily applied with a brush. Its outstanding quality is that it does not set, but expands and contracts freely and therefore tends to hold joints tight under vibrations or shocks. It is also pointed out that it does not check, crack or pull away from the surface to which it has been applied. It is impervious to oil, acids and chemicals.

Round Chart Recorder for Switchboards

THE small-sized round-chart recorder now being put out by the Bristol Company, Waterbury, Conn., is designed to fill the need for voltmeters and ammeters in modern power stations where it is essential that the instruments be grouped with as little waste of space as possible.

The voltmeter is available with either of two forms of measuring element. The moving-coil type embodies a fixed and movable coil connected electrically in series. In the moving-iron type the armature takes the form of a disk built up of an alloy of high permeability and low losses, lying in the field of a short, compact solenoid. In each case the moving part is carried on knife-edge springs, one of which is directly connected to the recording pen arm. The moving-coil type is used where a complete scale is required, the graduations gradually widening as the upper ranges are approached. The moving-iron type of element pro-



Round chart recorder with rectangular case for close mounting

vides uniform width of graduation through a limited range, and is particularly suited to calibration with a suppressed zero.

Recent Publications

ARC-WELDING: Lincoln Prize Papers Submitted to the American Society of Mechanical Engineers. Edited by Edward P. Hulse. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York City, 1929. Cloth; 6 x 9 in.; 421 pages. Price, $5.

LAST YEAR prizes aggregating $17,500 were awarded for the best three papers disclosing advancement in the art of electric arc-welding. While these were financed by the Lincoln Electric Company, the contest was sponsored by the American Society of Mechanical Engineers and the awards were made by a disinterested committee of eight prominent engineers. This book, composed of the three prize papers, of two receiving honorable mention and two others of the 77 submitted, is ample evidence that the incentive was adequate. It is easily the most important contribution yet made to the literature of arc-welding.

"Arc-Welding—Its Fundamentals and Economics," which brought the first prize, of $10,000, to James W. Owens, is a masterful crystallization of the author's extensive experience as director of welding for the Newport News Shipbuilding & Drydock Company. While Mr. Owens, naturally, stresses shipbuilding applications, he finds ample space in the 180 pages of his paper for the fundamental treatment of arc-welding in general. The attention given to definitions, nomenclature, standards and specifications, and the author's definitely practical viewpoint throughout add much to the value of the paper.

"Fundamental Principles of Arc Welding," for which Prof. H. Dustin, of Brussels, Belgium, received the second prize, of $5,000, proceeds from systematic analyses and tests of the elementary welds to an experimental study of joints for structural work. His conclusions are general in their application.

Commander H. E. Rossell, of the U. S. Naval Academy, who won the third prize, of $2,500, with his paper "Electric Welding of Ships' Bulkheads and Similar Plated Structures," makes a distinct contribution to the science and art of naval architecture. Incidentally, in dealing with ships, the largest and most complex of all steel structures, he adds definitely to structural knowledge in general.

In his paper on the "Theory and Application of the Base-Plate Arc-Welded Rail Joint," Frank B. Walker, chief engineer of the Eastern Massachusetts Street Railway Company, outlines extensive tests of rail joints in laboratory and field and gives designs and cost figures for commercial applications.

"Stable Arc-Welding on Long Distance Pipe Lines," by B. K. Smith, president of the Big Three Welding and Equipment Company, is mainly a brief history (with cost) of the laying of 45 miles of arc-welded pipe line for natural gas.

"Arc-Welding As Applied to Constructive Work at the Philadelphia Navy Yard," describes the construction of a steel pressure-resisting boiler test room and experiments on the welding of T bars to armor plate. The authors are M. M. Kennedy and F. H. Wieland of the Philadelphia Navy Yard.

In "Arc-Welding of Duplicate Structures," W. G. Hines describes methods used in the fabrication of interchangeable arc-welded truck switch frames.

Undoubtedly these papers, particularly the three prize winners, add much to our knowledge of the rapidly developing art of arc-welding.

THE OXY-ACETYLENE WELDER'S HANDBOOK. By M. S. Hendricks, Editor, *The Acetylene Journal*. Published by the Acetylene Journal Publishing Company, 608 So. Dearborn St., Chicago, 1929. Imitation leather; 4¼ x 6½ in.; 205 pages. Price, $3.

A PRACTICAL working manual of instruction for oxy-acetylene welders. The treatment throughout is simple and easily followed. After explaining the equipment and its care, the book gives detailed instructions for making various types of welds according to the latest practice. A chapter is devoted to various faults of welds and another to the training of operators. While most of the space is, naturally, devoted to the welding of soft steel, attention is given to the welding of other materials, such as high-carbon steel, chromium alloys, malleable iron, aluminum, Monel metal, nickel, lead, copper, bronze, brass, etc. Concluding chapters discuss testing and explain methods of handling special applications, such as tanks, pipes, sheet metal work, etc.

AN X-RAY STUDY OF FIREBRICK. By Albert E. R. Westman. Published as Bulletin No. 193, Engineering Experiment Station, by University of Illinois, Urbana, Illinois, 1929. Paper; 6 x 9 in.; illustrated; 16 pages. Price, 15 cents.

THIS booklet recounts an X-ray study of fourteen different brands of firebrick and a comparison of results with similar studies made on mullite, cristobalite, quartz and alumina. Apparently, this method of study gives a means of identifying important constituents of the brick, such as mullite or quartz, and comparing one brick with another. Hence, it may prove useful as a method of predicting the performance of a given brand in terms of the known performance of other brands. At present X-ray studies of this nature are too few to permit an accurate forecast of their utility.

THE CREEP OF STEEL AT HIGH TEMPERATURES. By F. H. Norton. Published by the McGraw-Hill Book Company, Inc., New York, 1929. Cloth; 6 x 9 in.; illustrated; 90 pages. Price, $3.

WITH the increasing temperatures used in boilers, the power engineer is forced to take a more scientific, intelligent interest in the behavior of metals under the new conditions encountered. When it is remembered that these temperatures now reach 1,000 deg. F. and shortly may be even higher, the importance of knowing the physical behavior of the steels to be used is evident.

Metallurgists and physicists have been alive to this need for increased knowledge for some years past, and much creditable work has been done, particularly in the determination of the so-called "creep" of steel. This phenomenon is concerned with the fact that steels act like extremely viscous fluids when maintained at a high temperature under stress, exhibiting a continued elongation without increase in stress. In other words, steels flow.

The work described in this volume consisted of creep tests carried out on seventeen different steels by the author, who is Babcock & Wilcox research fellow at the Massachusetts Institute of Technology. Metals tested included five austenitic steels, five stainless steels and seven carbon and alloy steels.

Results of the tests are fully reported and are compared with results obtained by French, Clark, White, Tapsell, Clenshaw and others. From these tests the conclusion is drawn that at temperatures over 1,000 deg. F. the austenitic steels offer far the greatest resistance to "creep."

CODE FOR PROTECTION AGAINST LIGHTNING. Published by the Bureau of Standards, Washington, D. C., 1929. Paper; 5 x 7½ in.; 114 pages. Price, 25 cents.

THIS bulletin contains standards of practice for lightning protection approved by the American Standards Association. It deals with the protection of persons, live-stock, trees, buildings, oil tanks and other structures and was prepared by a committee representing the Bureau of Standards and the A.I.E.E. "The fundamental theory of lightning protection," the bulletin points out, "is to provide means by which a discharge may enter or leave the earth without passing through a non-conducting part of the structure." In the matter of lightning rods the bulletin goes into questions of practical construction and sets forth requirements in detail. The fact that lightning rods have, in many cases, come into disrepute is laid to the lack of information, and it is hoped the code adopted will teach the public to demand adequate protection. An appendix describing the origin, characteristics and effects of the various forms of lightning and static charges, and a bibliography on the subject are included in the publication.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. Morrison

FEEDING BOILER COMPOUNDS—*What are the methods of supplying boilers with compounds for prevention of scale?* L.H.D.

Compounds may be introduced into the boiler continuously or intermittently, but small quantities introduced continuously or at short intervals are more effective than large quantities at long intervals. For continuous feeding, connect the suction side of the feed pump with a small reservoir (arranged like an ordinary cylinder oil lubricator) containing the compound in solution. In large plants it is common practice to use an independent pump to force the solution into the feed line and thus relieve the regular feed pump of contact with the boiler solution. Intermittent feeding of the compound is performed by temporarily connecting the regular feed pump suction with the reservoir containing the compound.

SAFETY VALVE CAPACITY—*Our boiler room contains four 5,000-sq.ft. boilers, which we are changing over from hand to stoker fired. With hand-firing the maximum rating we could obtain was 150 per cent, while with stokers we expect to be able to operate at 250 per cent. Will the four 3-in. diameter safety valves now on the boilers be satisfactory, or will it be necessary to add relieving capacity? The boilers now operate at 185-lb. pressure.*

The A.S.M.E. Boiler Code requires that the safety valve capacity for each boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6 per cent above the maximum allowable working pressure. The minimum aggregate relieving capacity of all of the safety valves required on a boiler shall be determined on the basis of 6 lb. of steam per hour per square foot of boiler heating surface.

The code also prescribes that the capacity of the valve shall be stamped or otherwise marked on it. As you have not mentioned the capacity of the valves in your letter, I assume that the markings have become illegible, and therefore the capacity will have to be computed from the A.S.M.E. equation, which for a 45 deg. bevel seated valve is $W = 110 \times P \times B \times L$, where W is the discharge in pounds per hour, P is the absolute pressure, B the diameter in inches and L the vertical lift of the valve disk. Substituting in this equation and assuming a lift of 0.11 in., we have $110 \times 206 \times 3 \times .11 = 7{,}500$ lb. per hour (approximately), the capacity of the valve at a 3 per cent overpressure. The four valves on your boiler will thus have a capacity of $4 \times 7{,}500$, or 30,000 lb. an hour. This meets with the minimum requirements of 6 lb. per square foot of surface and is greater than the maximum steam generation you are able to maintain, which at 150 per cent rating would be about 22,700 lb. an hour.

At 185-lb. pressure (200 lb. abs.), and assuming 200-deg. feed water, the heat added to each pound of steam evaporated is equal to $1{,}198 - 168 = 1{,}030$ B.t.u., and the steam generated at rating per hour per square foot of boiler surface is equal to $3{,}348 \div 1{,}030$, or 3.24 lb. per hour. Thus, at 250 per cent rating, the weight of steam generated per boiler is equal to $5{,}000 \times 3.24 \times 2.5 = 40{,}500$ lb. per hour. The capacity of the safety valve must be increased to this amount.

This can be done by adding two 3-in. safety valves similar to those now on your boiler, giving a total relieving capacity of 45,000 lb. an hour. It is probable, however, that the addition of one modern high-lift valve, which would probably have considerably greater capacity than those now on your boilers, would be found sufficient.

AMOUNT OF ASHES FROM BOILER—*How many cans of ashes would one have after a six-hour run of two 1,000 sq.ft. boilers operating at full capacity. The buckwheat coal has 18 per cent ash. How many pounds of steam at 100 lb. gage would you expect to evaporate per hour with these two boilers?* J. M. L.

When operated at rating a boiler absorbs 3,347.9 B.t.u. per square foot of heating surface per hour. At 100-lb. gage the steam tables show that a pound of dry saturated steam has had added to it 1,188.8 B.t.u. measured from water at 32 deg. F., but the water entering the boiler is at some higher temperature, say 200 deg. F., in which case each pound of water contains 168 B.t.u. The difference, $1{,}188.8 - 168 = 1{,}020.8$ B.t.u. must be added in the boiler.

Thus the weight of water evaporated from 200 deg. F. to dry steam at 100 lb. gage per square foot of boiler surface is $3{,}347.9 \div 1{,}020.8 = 3.279$ lb. per hour, and for the two boilers operating at normal rating the steam generated would be 6,558 lb. per hour.

Since you do not state the boiler efficiency, it will be assumed that you are evaporating 7 lb. of water per pound of coal, or $6{,}558 \div 7 = 936$ lb. of coal burned per hour. If 18 per cent is ash, $936 \times 0.18 = 168$ lb. of ash per hour.

GROANING OF PUMP—*We have a small reciprocating steam pump, used mostly at night, that has become a nuisance because it makes a groaning noise. What is the cause and how can the trouble be remedied?* B.H.H.

The noise is probably coming from the water end of the pump, and is likely caused by eccentricity of the water piston packing, which causes the piston rod to be held to one side and bind in the packing.

Remove the rod packings and observe whether either or both water and steam end rod packings are worn more on one side. This also would occur from unequal pinching by the packing as a result of improper size of packing, eccentricity of the stuffing box, careless placing of packing, setting the gland nuts tightly, or having beveled ends in the stuffing box or gland.

To determine whether the piston travels in proper alignment, remove the rod packing from the stuffing box of the water end and observe whether the rod moves up and down or sideways with respect to the stuffing box when the pistons are moved the full length of the stroke. If so, see whether this can be corrected by turning the pistons and rod to a new position or by repacking the pump.

PREPARING SULPHUR STICKS AND CANDLES—*How are sulphur sticks and sulphur candles prepared for locating leaks in a refrigerating system?* J. L. S.

Melt the sulphur by placing it in a flat-bottomed can or pan heated to about 250 deg. F. Sufficient heat usually may be obtained by placing the vessel in direct contact with a hot steam pipe or engine steam-chest cover, or in a boiler uptake. If the melting is done over a fire or flame, the vessel should be supported on an iron plate to prevent overheating and ignition of the sulphur. For making sulphur sticks, twist together three or four strands of candle wick. Cut it up into lengths about 12 in. long, dip these into the molten sulphur for a few minutes and withdraw to cool in form of a rough candle. If candle wick is not at hand, very good sulphur sticks can be made by dipping splints of soft wood into the molten sulphur.

Better forms of candles are made in molds. A candle mold is readily improvised by rolling sheet asbestos into tubes that have their lower ends packed in fireclay and with the lamp wick stretched through the tubes. The tubes are filled with molten sulphur. When the sulphur has cooled, the candles are in convenient form for use.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IF a two-stroke-cycle crankcase-scavenging oil engine can show a full-load fuel consumption of 0.42 lb. per brake horsepower-hour and a mean effective pressure of but 45 lb. per square inch, why do not the Diesels now using a mean effective pressure of 75 to 90 lb. drop to 45 and thereby better their fuel consumption?

G. V. M.

IF THE mean effective pressure of a four-stroke-cycle engine is decreased to 45 lb. per square inch, it means that the engine is developing only about half of the power of which it is capable.

It is an established fact that the fuel consumption of an oil engine increases with a decrease in load because of the decrease of mechanical efficiency. Therefore, lowering of the mean effective pressure will make the fuel consumption per brake-horsepower not better, but worse, and will increase it from 25 to 35 per cent.

Furthermore, lowering the engine rating almost to half of the customary rating would increase about twice its weight and cost per horsepower, making the installation of such an engine prohibitive on account of high first cost and correspondingly high fixed charges.

A low mean effective pressure of 45 lb. is not an advantage of a two-stroke-cycle oil engine with crankcase scavenging, but rather an unavoidable evil caused by the poor scavenging and lack of oxygen in the air charge.

Finally, I doubt whether a two-stroke-cycle engine with crankcase scavenging is capable of showing such a low fuel consumption as 0.42 lb. per brake-horsepower and such a high mean effective pressure as 45 lb. My own experience and statements in the technical literature are that fair figures would be 0.50 lb. per brake-horsepower and 35 to 38 lb. per square inch, respectively.

V. L. Maleev,
Consulting Engineer,
Western-Enterprise Engine Co.
Los Angeles, Calif.

WITHOUT any further data, I would guess that this oil engine was running as a Diesel. The Diesel principle is to burn the oil in the cylinder, not to explode a gasified charge, the idea being that the explosion type developed so much higher heat than plain combustion that much of it was wasted through radiation and jacket water and exhaust gases.

In modern parlance, we restrict the word "Diesel" to high-compression engines. Yet other oil engines, not so classed, are operating on the original Diesel theory and approach the same economy.

High rotative speed is frequently desirable, and is easiest obtained with a short stroke, other things being equal. For this reason, the mean effective pressure is subservient to other factors; lower mean effective pressure would require less oil, consequently the cylinder would need to be larger to give the same power.

Experimental laboratories have found that theoretical considerations do not always bring practical results, and the saving does not justify the change. Dr. Diesel predicted that his engine would utilize one-third of the energy in the fuel in each direction, work, jacket water and exhaust gases. All experiments to attain any higher saving have usually been too expensive to be remunerative.

L. R. Baker,
Chicago, Ill. National Acme Co.

PERMIT me to parry the question as to why the present type of Diesel engine cannot operate at lower pressures and thus obtain reduced fuel consumption with a counter-question: Could a jackrabbit equipped with the hind legs of a kangaroo developed greater speed? Possibly so, providing that the remainder of the rabbit and the surrounding terrain were adapted to the change. Practically the same analogy would apply to the engines in question.

As you state, the two-stroke-cycle oil engine has attained remarkable efficiency with reduced pressures. The conventional Diesel engine, however, approaches complete expansion, and consequently maximum efficiency, with increased compression, to certain limits. The German Diesels operate at pressures often exceeding 500 lb. per square inch, with fuel consumption ranging from 0.37 to 0.44 lb. per brake horsepower-hour, while American Diesels employing lower pressures require from 0.48 to 0.52 lb. per brake horsepower-hour of similar fuel.

It is not the relatively high pressures, but the large temperature increases, they produce that make for Diesel efficiency. Diesel engines can be adapted to operate more efficiently at lower pressures through the provision of preheated intake air to supplement the decreased temperature rise in producing the correct ignition temperature.

R. H. Wood,
San Diego Con. Gas & Elec. Co.
San Diego, Calif.

THE two-stroke-cycle, crankcase-scavenging oil engine achieves its low full-load fuel rate as a result of its extreme simplicity. By eliminating the scavenging pumps, injection-air compressor and all valve gear except the starting valves and a simple fuel-injection system, the friction load is reduced, so that, while the gross power developed per unit of cylinder volume is less, the over-all working efficiency compares favorably with the engines operating at a much higher mean effective pressure.

Examination of the test data of a number of Diesel engines, both two- and four-stroke-cycle, that operate on a full load mean effective pressure of 75 to 90 lb. per square inch shows that as the mean effective pressure is reduced to 50 lb. or less, the fuel ratio per indicated horsepower per hour varies slightly, the mechanical efficiency decreases and the fuel rate per brake horsepower per hour increases. This is due to the fact that at the lighter useful load corresponding to the lower mean effective pressure the friction load forms a higher percentage of the indicated horsepower developed.

Howard Livingston.
Los Angeles, Calif.

THE readers who replied to the question have fallen quite short in completely answering it.

If one will construct a fuel-consumption curve for a four-stroke-cycle air-injection Diesel it will be found that the engine is rated at a mean effective pressure somewhat beyond the point where the lowest fuel consumption is obtained. On the other hand, usually the two-stroke-cycle crankcase-scavenging engine is rated at the mean effective pressure giving the lowest fuel consumption. This point may be such that the fuel consumption per brake horsepower is no higher than the fuel consumption of a four-stroke-cycle engine at its rated load. But if the latter engine is operated at three-quarters load, the mean effective pressure corresponds to the lowest point on the fuel curve, so that the fuel per brake horsepower-hour is but slightly, if any, higher than at full load; if the two-stroke-cycle engine's load is dropped to three-quarters, the mean effective pressure corresponds to a point on the fuel-consumption curve considerably above the lowest point, so its three-quarter load fuel rate is higher than the full-load rate.—L. H. M.

A Question For Our Readers

I HAVE frequently read that the plant engineer should determine the quantity of carbonates, bicarbonates and hydrates that make up the total alkalinity of the feed and boiler water. How can I use this information to guide our feedwater treatment? G.S.B.

Suitable answers from readers will be paid for and published in the October 29 issue.

Tentative Code for Pressure Piping Sponsored by A.S.M.E.

ONE section of the "Code for Pressure Piping," covering the design, manufacture, test and installation of power-piping systems in steam-generating stations, central heating plants, industrial process work and all distribution systems where the pressure is in excess of 15 lb., has been published by the A.S.M.E. in tentative form for critical review and discussion.

Some of the more important of the recommended practices follow:

VALVES—All valves shall be plainly marked with the name or identification mark of the maker and the working steam pressure for which they are guaranteed.

THERMAL EXPANSION—In general, thermal expansion shall be taken up by pipe bends, offset or changes in direction of the pipe line itself. Expansion joints of either the slip-sleeve or swivel type may be used for the pressure and temperature for which the connecting pipe is suitable, provided, however, (*a*) the materials, including the packing, used in their construction are suitable for the service intended; (*b*) the design provides proportions for the structure and working parts ample therefor; and (*c*) for pressures in excess of 15 lb. the design embodies provision against complete disengagement of the working parts while in service.

Unsupported corrugated expansion joints shall not be used for steam pressures exceeding 25 lb. per square inch. Corrugated expansion joints when reinforced with exterior rings or sleeves may be used for steam pressures not exceeding 125 pounds.

The maximum combined fibre stress due to internal pressure, thermal expansion and deadweight between supports shall not be in excess of 15,000 lb. per square inch. It is recommended that piping shall be cut short about 50 per cent of the amount of thermal expansion and cold-spring during erection. The amount of cold-springing, however, shall not be credited as reducing the calculated bending stress due to thermal expansion.

REDUCING AND RELIEF VALVES—Where reducing valves are used, one or more relief or safety valves shall be provided on the low-pressure side of the reducing valve, in case the piping or equipment on the low-pressure side is not adequate to stand the full pressure. The combined discharge capacity of the relief valves shall be such that the pressure rating of the lower-pressure piping and equipment shall not be exceeded in case the reducing valve sticks open. The use of hand-controlled bypasses around the reducing valve is permissible; reducing-valve bypass, if used, shall not be greater in size than the reducing-valve inlet. Exhaust lines for any service and pressure shall be provided with relief valves of suitable size, unless such lines are designed for the maximum pressure to which such lines may accidentally or otherwise be subjected.

HANGERS AND SUPPORTS—Hangers for pipes larger than 3½ in. shall be capable of screw adjustment after erection. Supports of rigid construction, such as piers, or brackets, for pipe 3½ in. in size and larger should be fitted with concave rollers, machined guide blocks or their equivalent in cases where the piping is subject to thermal expansion. Hangers and supports, except in the case of springs, shall have a factor of safety of 12 with reference to the ultimate strength of the material. All weight calculations shall be based on piping full of water, with heat insulation included if such is to be used.

SLEEVES—Where pipes pass through walls, partitions, floors, beams, etc., not constructed of metal or other non-combustible material, a protecting metal sleeve or thimble shall be provided which gives a clearance of not less than ⅛ in. all around the pipe or pipe and covering. In the case of steam pipes passing through metal partitions, etc., a clearance of at least ¼ in. under hot and cold conditions shall be left all around the pipe, and if the steam temperature exceeds 250 deg. F., the pipe shall be insulated inside the sleeve with covering of at least standard thickness. Exception may be had to these rules in the case of pipes passing through walls or partitions, etc., which must be kept watertight.

This code, prepared under the procedure of the American Standards Association by a committee representing the A.S.M.E., sponsor for the project, is the third section of the "Code for Power Piping Systems" to be prepared. Some of the more important points are summarized on this page. Comment is invited and should be addressed to C. B. LePage, assistant secretary, A.S.M.E., 29 West 39th St., New York.

DRIP LINES—Drip lines from steam headers, mains, separators, or other equipment operating at different pressures, shall not be connected to discharge through the same trap. Where two or more drips discharge in the same trap, a check valve and a stop valve shall be placed in each line. Where several traps discharge in one header under pressure, or which may be under pressure, a stop valve and a check valve shall each be placed in the discharge line from each trap.

HYDROSTATIC TESTS BEFORE ERECTION—Piping, valves and fittings shall be designed to withstand a hydrostatic shell test to the following pressures per square inch. Tests to be made before erection:

STANDARDS FOR HYDROSTATIC TESTS

W. S. P. Rating, Lb.	Test, Lb.
1,350	3,000
900	2,000
600	1,500
400	1,000
250	750
150	450
125 (16 in. and smaller)	250
125 (18 in. to 32 in.)	200
125 (36 in. and larger)	150
25	50

THICKNESS OF PIPE—In determining the minimum thickness on inspection to be used for pipes at different pressures for temperatures not exceeding 750 deg. F. for steel or iron pipe, 406 deg. F. for brass and copper pipe, and 450 deg. F. for cast iron, the following formulas are to be used:

For pipes having nominal diameters of from ¼ in. to 5 in.:

$$P = \frac{2S}{D}(t - 0.065) - 125.$$

For pipe of nominal diameters of over 5 in.:

$$P = \frac{2S}{D}(t - 0.1).$$

Where P = working pressure, lb. per sq. in.
t = minimum thickness of wall of pipe, in.
D = actual outside diameter of pipe, in.
S = 9,000 lb. per sq. in. for seamless steel pipe.
S = 7,000 lb. per sq. in. for lap-welded steel pipe.
S = 5,000 lb. per sq. in.. for butt-welded steel pipe.
S = 5,300 lb. per sq. in. for lap-welded wrought iron pipe.
S = 4,500 lb. per sq. in. for butt-welded wrought iron pipe.
S = 4,500 lb. per sq. in. for brass pipe.
S = 4,000 lb. per sq. in. for copper pipe.
S = 3,000 lb. per sq. in. for cast iron.

Specific mandatory requirements for steam pressures from 250 lb. to 1,350 lb. and temperatures from 450 deg. to 750 deg. F.

VALVES AND SCREWED FITTINGS—All valves and fittings in nominal sizes under 2 in. may have either screwed or flanged openings. All valves and fittings of 2 in. nominal size and larger shall have openings flanged, except that drip connections, etc., smaller than 2 in. may be either flanged or threaded. Stem threads on gate and globe valves shall be external with reference to the valve body and used in connection with an outside yoke and flanged bonnet. Steam valves 8 in. and larger shall be

bypassed with a bypass of at least ¾ in.

PIPE—For pressures in excess of 400 lb. the pipe shall be seamless open-hearth steel pipe, made in accordance with the A.S.M.E. specifications A-106. For pressures from 250 lb. to 400 lb. pipes shall be either lap-welded or seamless open-hearth steel or wrought iron.

Requirements for steam pressures from 125 lb. to 250 lb. and temperatures not in excess of 450 deg. F.:

VALVES—All gate and globe valves 2 in. and larger shall have outside screw and yoke except where clearance limitations require the use of a non-rising steam valve, in which case an indicator shall be provided. Bodies, bonnets, disks and yokes shall be of cast iron or other material allowed under this code. Gate and globe valves under 2 in. in size may have inside screw. All gate valves 8 in. and over shall be bypassed. If pipe is used in bypass it must be extra strong steel or wrought iron. American Standard 150-lb. malleable-iron screwed fittings or American Standard 150-lb. steel fittings may be used up to 150 lb. steam pressure. Pipe shall be of steel, wrought iron, copper or brass. Bolts shall be steel or wrought iron.

Requirements for boiler feed systems and hot-water systems over 250 deg. F.:

Boiler-feed piping systems exceeding 1,080 lb., and up to 1,625 lb., shall be designed as for 1,350 lb. steam pressure.

Boiler-feed piping systems exceeding 720 lb., and up to 1,080 lb., shall be designed as for 900 lb. steam pressure.

Boiler-feed piping systems exceeding 500 lb., and up to 720 lb., shall be designed as for 600 lb. steam pressure.

Boiler-feed piping systems exceeding 325 lb., and up to 500 lb., shall be designed for 400 lb. steam pressure.

Boiler-feed piping systems exceeding 175 lb., and up to 325 lb., shall be designed for 250 lb. steam pressure.

Boiler-feed piping systems for pressures below 175 lb. shall be designed for 125 lb. steam pressure.

No bypasses around valves shall be required for pressures under 600 lb. For pressures in excess of 600 lb. it is recommended that all valves 8 in. and over in size be equipped with bypasses of at least ¾ in. nominal size.

Brass or copper pipe may be used where pressure of 300 lb. gage, or a temperature of 406 deg. F., is not exceeded.

BLOWOFF PIPING — Blowoff piping systems shall be designed for maximum pressures of the connected boiler, except that the 600-lb. material may be used for boiler pressures above 600 lb. This applies to the entire system, from blowoff valves on boilers to the blowoff tank or other points where the pressure is reduced to approximately atmospheric pressure and cannot be increased by closing a valve.

Research Progresses on Metal Cutting, Wire Rope; A.S.M.E. Lubrication Committee to Spend $20,000

BY A. A. POTTER

Dean of the Schools of Engineering and Director of Engineering Experiment Station, Purdue University

COLLECTION and interpretation of existing data on milling, tapping, threading and reaming with a view to clarifying research done in the field of metal cutting is now being carried on by the A.S.M.E. special research committee on cutting of metals. Valuable work not generally known and not clearly understood relating to the action of cutting fluids, the establishment of machinability ratings, the possibilities and effects of tungsten carbide cutting tools is being done under the direction of Prof. O. W. Boston at the University of Michigan, and Prof. J. D. Hoffman at Purdue University. The results of the former's efforts will appear as a research publication of the A.S.M.E. this fall. The committee is at present engaged in raising funds from industry to further the research, and the assistance of the University of Illinois and Carnegie Institute of Technology in extending the bibliographical work is assured.

The great possibilities of high speed turning which are resulting from the development of tungsten carbide cutting tools are being investigated by a subcommittee of the cutting-of-metals group. F. C. Spencer, of the Western Electric Company, heads the subcommittee.

An enlarged research program that will call for an expenditure of $20,000 over a period of two years is planned by the special research committee on lubrication of the A.S.M.E. The programs will be divided into two parts, one being the publication of a collection of important foreign and domestic literature on the subject, and the other being the continuation and enlargement of investigations on effective lubricants, design of bearing surfaces and mountings, and the phenomenon of oiliness. Most of the work will be carried on at the Bureau of Standards, utilizing a trained personnel and technique which has been developed during the past fourteen years of the existence of the committee.

Investigations at present in progress in which the committee is co-operating are (*a*) an experimental test of the hydrodynamic theory of lubrication at the Pennsylvania State College, using a journal bearing machine designed by Mr. Kingsbury and loaned to the college for this purpose; (*b*) experiments on pressure distribution in oil films at the Kingsbury Machine Works by means of electrical observations on large-scale models; and (*c*) experiments on waste-packed bearings, ring oiling and forced lubrication in the research department of the Westinghouse Electric & Manufacturing Company.

The personnel of the committee includes several of the best-known lubrication experts in the country. Mayo D. Hersey, chief of the Friction and Lubrication Section of the Bureau of Standards, Washington, D. C., is chairman; Messrs. Alan E. Flowers, Louis J. Bradford, Hobart C. Dickinson, H. A. S. Howarth, Albert Kingsbury, George B. Karelitz, Earle Buckingham, Arthur E. Norton and L. P. Alford, are members.

WIRE ROPE RESEARCH

The Third Wire Rope Conference, comprising some 50 engineers representative of the many fields of wire rope products met in New York on Friday, Sept. 13. They adopted the following resolution:

Whereas, the discussion at this conference has revealed:

1. That wire rope is subjected to many and varied conditions of service;
2. That there is great variation in the life of wire rope; and
3. That there seems to be no accurate method of predicting wire rope life or of determining when its useful life is up

Be it resolved, that a co-operative research committee be organized under the auspices of Engineering Foundation and the American Society of Mechanical Engineers and with the co-operation of other interested technical organizations to make a study of the factors affecting wire rope life for the purpose of:

1. Formulating rules of recommended practice for the use and inspection of wire rope;
2. Emphasizing the factors to be considered in applying wire rope to its various uses; and
3. Pointing out possible improvements that might be made in the design, materials, and fabrication of wire rope and wire-rope-using machinery.

Be it further resolved, that the research program adopted be developed according to the present research procedure of the American Society of Mechanical Engineers.

Among the distinguished participants in the conference were Elmer A. Sperry, president of the A.S.M.E., and Dr. Conrad Matschoss, director of the Verein Deutscher Ingenieur of Germany. Mr. Sperry emphasized the present need for a better knowledge of wire rope and described a new method of non-destructive test that is showing great promise. Dr. Matschoss outlined the important research work that is being conducted in Germany on this widely used machine element and offered co-operation to the proposed American project. Further evidence of the exhaustive study being given wire rope abroad was revealed in a paper by Dr. W. A. Scoble, reporter for the wire rope committee of the Institution of Mechanical Engineers in Great Britain.

Heat Transfer in Reciprocating Engines

That the total heat transmission from steam to wall in a uniflow steam engine cylinder continues much longer than the admission period, that the cover of the cylinder plays a negligible part in the heat interchange, and that heat fluctuations in a Diesel engine cylinder are comparatively great are some of the conclusions drawn from a series of experiments conducted on uniflow and Diesel engines at Dresden, Germany.

SINCE the first success of the uniflow steam engine and the Diesel there has been a need for more knowledge of the laws which explain the thermodynamic advantage of these engines. Many theories have been formulated but until recently accurate empirical data with which to substantiate them have been lacking. In an effort to shed more light on the subject Prof. Dr. Ing. A. Nagel and Professor Mollier initiated and carried out a series of experiments at Dresden, Germany, to determine the heat transmission between the steam or gas and the engine cylinder walls. Professor Nagel has described the results of these tests in recent issues of *Engineering*, of London, from which the present article is abstracted.

Four laboratory tests were made on a uniflow steam engine cylinder and one test was made on a Diesel engine cylinder. Numerous runs were made in each of these tests to check the accuracy of the measurements taken, and a high degree of precision was attained.

Tests With Uniflow Steam Engine

For the steam engine test a uniflow cylinder with a diameter of 450 mm. was used. The stroke of the piston was 650 mm. and the cylinder was fitted with a Lentz valve gear. Specially constructed thermocouples were used at as many points as possible on the cylinder to measure the temperatures of the steam and walls. In all the tests steam was admitted to the cylinder at a pressure of eleven atmospheres absolute (about 157 lb. per sq.in.) and the back pressure was kept constant at exactly 0.05 atmosphere (28.5-in. vacuum). Two low-speed (81.8 r.p.m. and 75.1 r.p.m.) and two high-speed (149.5 r.p.m. and 150.2 r.p.m.) tests were made with saturated steam at 7 deg. C. superheat and with superheated steam at 350 deg. C. The indicated horsepower ranged from 106.7 to 185 with a belt-driven generator as a load. The engine ran double-acting in all four tests.

One of the first indications of the tests was obtained from temperature measurements at five points on the cover of the cylinder. The variations in the temperatures of these points were remarkably small, amounting only to one or two deg. C., even where saturated steam was used at low speed. This led to the conclusion that the cover takes a small part in the heat transfer. It is important to note this result indicates, at least in the case of saturated steam, that the thermal economy of the engine is not improved by heating the cover, as is so often done in engines of this type.

On the other hand, the piston rings play an extremely important rôle in the heat transmission between steam and wall, but their influence on the temperature range of the cylinder wall decreases as the middle of the stroke is approached. This may be explained, firstly, by the diminished temperature difference between the lines of the wall and the piston rings, and, secondly, by the increase in piston speed.

Another striking observation of the tests was that for a well-insulated cylinder wall the heat flow outward to the atmosphere in its hot zone is smaller than in its cold zone. This is due solely to the omission of insulation at the cold zone. Furthermore, the continual heat flow through the walls over a long period of time depends only in a subordinate degree on the state of the admitted steam and the revolutions per minute of the engine.

Results of Saturated-Steam Experiments Significant

Results of the saturated-steam test at low speed are particularly interesting and have the same general characteristics of all the tests. They are as follows: (1) The total heat transmission from steam to wall continued much longer than the admission period; (2) the whole area of the cylinder cover received only 5 per cent of the total heat transmitted, while the piston surface took about 20 per cent; (3) of the total heat transmitted about half was taken up by the first third of the liner surface passed over by the piston rings, and this was never wholly redelivered to the working steam; (4) the remaining heat quantity reflowing from the hot part of the wall depended upon the piston rings only, especially upon the first one.

A few differences in the results obtained with saturated steam and superheated steam are worthy of note. In the low-speed tests there was a substantially smaller temperature fluctuation when superheated steam was used than when saturated steam was used. Also, there was much slower reheating of the wall, in spite of the correspondingly larger temperature difference between the two steam conditions at admittance.

For the Diesel engine test a two-stroke-cycle four-cylinder engine of 600-mm. bore and 1,160-mm. stroke was used. The normal power of the engine at 100 r.p.m. with separately driven scavenging blowers was 1,350 b.hp. Thermocouples were used at numerous points to record the temperature of the cylinder, cover, piston head and gas. Many runs were made at different loads, and measurements were taken while the engine was starting and stopping.

Tests With Diesel Engine

When running at full load the highest temperature recorded was 322 deg. C. at the upper end of the cylinder liner, which the piston rings do not reach. In the cover and piston the highest temperature observed was about 300 deg. C. With air injection of the fuel through a central valve, the inner edge of the cover had the lowest temperature, while the highest temperature was found about halfway between the central valve bushing and the outer circle. At a point 0.5 mm. below the rubbing surface of the top piston ring the temperature fell both during the expansion and compression strokes, and rose at both the upper and lower dead centers to a maximum of about 130 deg. C. The temperature variation was about 15 deg. C. at three-fourths load. A reading taken 1 mm. farther below the surface, with the same load, showed a variation in temperature of only 3 deg. C.

Before this experiment was carried out on the Diesel engine, it was commonly thought the surface of the walls exposed to the hot gases participate uniformly in the heat transfer. This assumption gave rise to the view that the heat interchange due to the periodic temperature variations of the working cycle was unimportant from the point of view of practical design. As a result serious errors were made in cases where the cylinder size was large and the speed low.

It must be concluded from this test, however, that in spite of small temperature variations, the heat fluctuations are comparatively great, and also that due to the fluctuation in the quantity of heat, the stresses in service may under certain conditions become dangerous. This is particularly true when starting and stopping a Diesel engine.

Compressive stresses occur on both the gas and water sides of the cylinder wall, while in the interior of the wall tensile stresses are produced. The tensile stresses vary little with time after starting. On the other hand, the compressive stresses increase very rapidly at first and then drop off as the engine gains speed. Since the wall cannot bend and expand, additional stresses are set up, which added to the first set may cause a failure of the wall. Breakdowns in Diesel engines have been known to occur for this very reason.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

CONSTRUCTION *of a 180,000-kw. steam-generating plant on tidewater at Salem, Mass., will be started in 1930, according to plans recently announced by Charles H. Tenney & Company, of Boston. It is expected the initial installation will consist of two 60,000-kw. units, a boiler plant to be operated at 450 lb. and coal-handling equipment whose nucleus is already one of the most extensive on the Atlantic Coast. The Eastern Massachusetts Electric Company will operate the plant when completed.*

* * *

A STEAM ENGINE *used to drive a 300-kw. generator for plant power requirements blew to pieces recently in the factory of the W. H. Dow Manufacturing Company at Waukegan, Ill., without injury to anyone. In preference to repairing the engine, the Dow company has decided to purchase power.*

* * *

PRESENT PLANS *for the electrification of the whole trunk railway system throughout Great Britain call for a large extension of the power-generating facilities of the United Kingdom.*

* * *

BREAKING ALL PREVIOUS RECORDS, *the Seattle municipal light and power system produced 29,356,800 kw.-hr. during the month of August, according to a report just issued by J. D. Ross, superintendent. Of this amount the Skagit River plant furnished 88.2 per cent.*

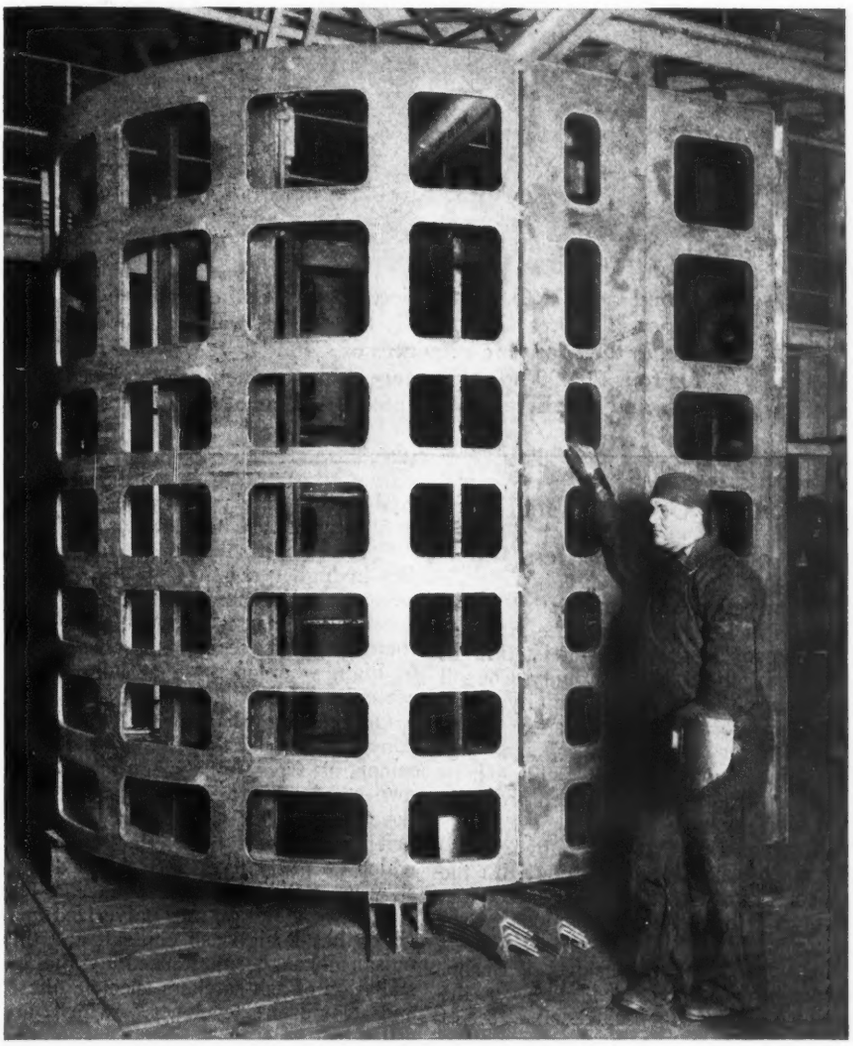
* * *

PLANS *for construction of a new 20,000-kw. steam-generating station at Granite Falls, Minn., have just been announced by the Northern States Power Company. Specifications call for the installation of two 10,000-kw. turbine-generators.*

* * *

NEW ORDERS *for 1,861 steel boilers of 1,789,989 sq.ft. were placed in August, as reported to the Department of Commerce by 80 manufacturers comprising most of the leading firms in the industry, as compared with 2,054 boilers of 2,083,449 sq.ft. in July and 2,018 of 1,691,394 sq.ft. in August, 1928.*

All Welded Turbine-Generator Stator Has Largest Rating for Speed



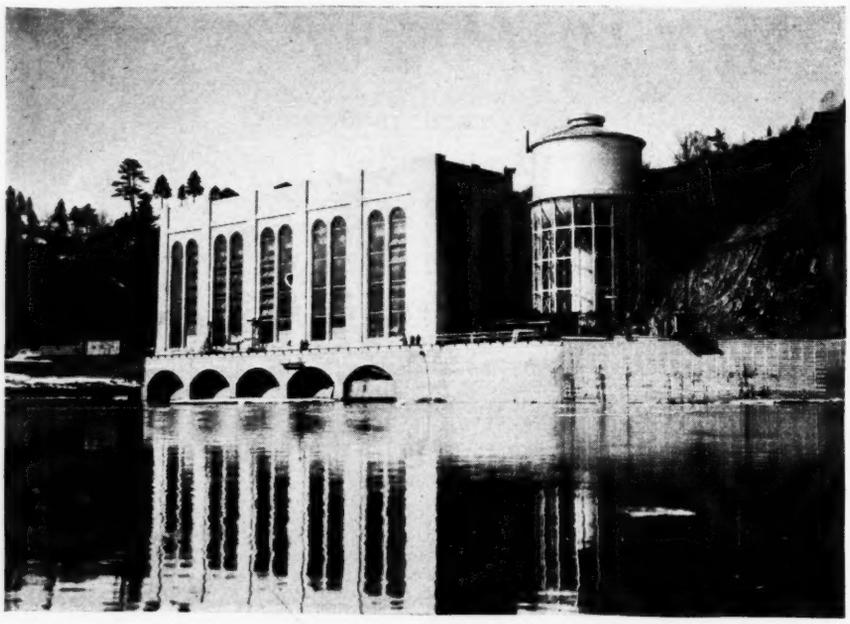
THE confidence which engineers and designers are placing in electric arc welding is exemplified in the turbine-generator stator shown in the illustration. The generator has a rating of 94,200 kva. at a speed of 1,800 r.p.m.—the largest rating yet built at this speed. This turbine-generator stator was assembled at the East Pittsburgh shops of the Westinghouse Electric & Manufacturing Company.

The stator is 220 in. long. It was made by fastening together rings cut from steel plates with automatic gas cutting machines. The rings are held together on the inside by axial bars welded in place, and on the outside by steel plates bent to shape and welded on. The supports for the frame feet are also made from steel plates.

The only machining required on the completed frame consisted of a light bore cut on the axial bars to which the lamination rods are to be welded and some machining on the plates to which the feet are bolted.

Another advantage of this type of construction is the reduction in weight. This arc-welded structural steel stator weighs 40,000 lb. less than an equivalent cast stator. It was possible, therefore, to wind the stator in the factory and ship it as a complete unit.

The turbine-generator, for which this stator was made, will be installed in the Hell Gate Station of the United Electric Light & Power Company in New York City.



THE Grand Falls, N. B., hydro-electric plant of the International Paper & Power Company is the largest water power station in the Maritime Provinces of Canada. It was designed for four 20,000-hp. generators, two of which are in operation and a third is in the process of installation.

London Consults Berlin on Fumes Problem

In connection with the incessant public protests in London against the proposed erection of a great power station at Battersea, the London County Council has asked the Berlin Electricity Company for information as to its experience in combating the smoke, ash, and sulphur fumes nuisance at its Klingenberg station. This request has been promptly and cordially met.

Klingenberg is a station of 270,000 kw., and is hardly comparable with the proposed station at Battersea, London. It is not located in a populous urban area, but in a thinly populated district on the south-eastern outskirts of Berlin. There are few visible traces in the vicinity of the supposedly evil effect of sulphurous gases; the Spree runs within 50 yards, and the trees on the bank are as green as elsewhere. The smoke issuing from the chimneys seems less in density than that emitted from the existing London power station at Lots Road. It is gray-brown, not black in color. German methods of smoke abatement are admittedly efficient. It must be added, however, that Klingenberg would not be a pleasant neighbor in such a thickly-inhabited district as Battersea.

The reply of the Berlin Electricity Company to the London County Council pointed out that there had been practically no complaints in regard to sulphurous fumes and that no harmful effects either upon the health of the population or upon vegetation had been noticed. The coal used has a comparatively low sulphur content. It is thought that the coal used in England may possibly have a higher one. The German engineers believe the best solution of this problem lies in higher chimney stacks. A new power station now being constructed between Siemenstadt and Spandau is, therefore, to have chimneys nearly 400 ft. high, whereas those at Klingenberg are only 225 ft. high.

On the other hand, the Berlin company reports that there have been many complaints from neighboring inhabitants, owners of cafés, and holiday-makers on the Spree about the floating ash and grit discharged from the chimneys, which on gusty days have descended in showers and caused annoyance. The Klingenberg station uses pulverized fuel, which has a high ash content, and this nuisance has been attacked by the installation of ash-catchers, electric filters, and Davidson "cyclones," which are estimated to trap 80 per cent of the total ash. Experiments are also being made with a water-washing process in which the waste gases are forced through several "veils" of water. It is believed that these will retain a large proportion of the ash and gases. It is also thought possible to trap part of the sulphur fumes in the same way.

Meanwhile the London Power Company has announced that its engineers and chemists have evolved a perfectly practical and commercial solution of the sulphur problem in which the company has complete confidence. Patent letters have been applied for in connection with the process. Its methods and results have been inspected by government chemists, and a full report is about to be sent by the company to the electricity commissioners.

Nova Scotia Mill to Have High-Pressure Steam Plant

A power plant of the latest design, equipped with 400-lb. boilers, using pulverized fuel and air preheaters, will form a part of Nova Scotia's first paper mill. This mill, now under construction near Liverpool, N. S., will probably be completed by Oct. 1 and will have an initial capacity of 250 tons of paper per day. A turbine-generator exhausting to process will supply 5,000 hp. to the plant.

The hydro-electric power development of the Mersey River which was undertaken by the Nova Scotia Power Commission, a complement to the Mersey Paper Company's undertaking and designed to supply the latter with 20,000 hp. required by it, is likewise making rapid progress. The construction of dams and walls at various points on the river is converting the river area and lakes into one basin, which within the next nine months will be flooded to provide 105 million kw. per year to the paper mill.

St. Lawrence Project Has Morgan Co-operation

The purchase of the Frontier Corporation, effecting a virtual monopoly of up-state New York hydro-electric power sites by the $450,000,000 Morgan superpower system, has led to another flare-up of the old "monopoly vs. public ownership" problem.

Franklin D. Roosevelt, Governor of the State of New York, sharply criticized the private developments on the St. Lawrence. Mr. Roosevelt took a firm stand that the state alone should be the agency for the utilization of these hydro-electric sites.

However, both the Niagara-Hudson Power Corporation and Thomas W. Lamont, senior partner of J. P. Morgan & Company, have formally pledged their co-operation with federal and state authorities in the development of the water power on the St. Lawrence.

Mr. Lamont made it clear that neither J. P. Morgan & Company, nor, so far as he knew, any of its associates, had taken any position for or against public or private ownership. Unification had been undertaken, he said, solely in the interest of more economical power.

Paper Mill to Build New Boiler Plant

An entirely new boiler plant will be erected by the Bedford Pulp & Paper Company of Richmond, Va., for its mill at Big Island, Va. Three 7,000-sq.ft. Edgemoor boilers to operate at a pressure of 450 lb. will be installed. Pulverized coal will be used as fuel with Unipulvo unit pulverizers and vorticose burners. A 5,000-kw., General Electric turbine will supply power for operating the mill, and will exhaust steam to process.

Claim May Hold Up Boulder Dam

An interesting claim to priority of water rights in the Colorado River is made by Capt. Jay Turley, former water commissioner of New Mexico, now of Los Angeles, who has submitted a proposition to Gov. William H. Adams of Colorado whereby necessity for the Boulder Dam may be obviated.

Captain Turley, who claims ownership of 16 per cent of the flow of the Colorado River on the strength of an early-day land grant which carried with it 4,000 sec.-ft. of water in New Mexico, advocates a $3,000,000,000 reclamation project through a series of dams in the Colorado River basin.

If Captain Turley's idea should find favor with Governor Adams, and with other Western states executives who are to be approached in the matter, it probably would change the tenor of the conference over water rights scheduled to take place in Denver Nov. 5. The conference of Governors has been called to attempt to settle apportionment of Colorado River waters among upper and lower basin states. Captain Turley believes the tentative compact under consideration is unfair to upper basin states. He would make drastic changes in the allocation of rights.

Refrigeration System Being Remodeled

Work is now in progress on the modernization of the refrigeration plant of the Union Storage Company, Pittsburgh, Pa. The old distilled water ice-making system, compressors, engines and steam boilers are being torn out for replacement with a raw water ice-making system, new compressors and an electrically driven power plant. New elevator equipment is also being installed in the building. This change will provide additional space of seven floors, now occupied by the old power plant equipment. Ophuls & Hill, Inc., consulting engineers of New York City, are in charge of the alteration work.

New Development in Hydro-Electric Field

The legal tangle in regard to the Goshen Pass, Va., hydro-electric site will be renewed at the November term of the Virginia Supreme State Court of Appeals. Last July the State Corporation Commission stated that it had no jurisdiction in this case, but a brief filed by the attorneys for the Garden Club of Virginia, which is opposing the dam as a mar to scenic beauty in the region, declares that the commission was in error and that the waters in the North River, although its bed is privately owned, are "waters of the state," and the commission has jurisdiction to rule on the license application. Whether or not the commission can so rule upon it is the matter which the Supreme Court of Appeals must decide.

The development of another hydro-electric plant in Virginia on the Roanoke River near Boydton is forecast, although plans have not yet reached a definite stage. The plant will be of 80,000 hp. capacity, it has been learned, and the site will comprise about 15,000 acres of land. Additional land is being acquired at the present time. The property has an estimated value of $600,000. A few miles lower on the Roanoke River is the Bugg's Island site, where the Carolina Power & Light Company plans to erect a large dam and power plant. Further south on the Virginia-North Carolina state line is the site of a 50,000-kw. development planned by the Virginia Electric & Power Company, and in North Carolina, two miles above Roanoke Rapids, the river will be dammed for another power project of the same company, which will produce 40,000 kilowatts.

Water began to fill what is to be one of the largest artificial lakes in the world a few days ago when the main diversion tunnel beneath the mammoth earthen dam at Lake Murray, $20,-500,000 power development near Columbia, S. C., was plugged. The lake will be 30 miles long, backing water to within a short distance of Newberry, and will have an average width of 14 miles. Ten months will be required to fill the basin with the 750 billion gallons of water which will be stored there. Work on the dam and plant will continue, and by the time the lake is filled the Lexington Power Company officials expect the turbines to be in operation.

A.S.M.E. to Hold Meeting at Akron, Oct. 21-23

A meeting of the American Society of Mechanical Engineers which promises to be one of exceeding interest will be held in Akron, Ohio, Oct. 21 to 23, at the Portage Hotel. Eight sessions are being planned under the auspices of the professional divisions and standing committees on the following subjects: Applied mechanics, materials handling, education and training for the industries, aeronautics, steam power, iron and steel, and management. At the steam power session, R. J. S. Pigott, consulting engineer for the Smoot Engineering Corporation, New York City, will present a paper on "Power and Heat in the Industrial Plant."

A dinner, followed by a smoker with entertainment, is being arranged at the Firestone Clubhouse for Monday evening, Oct. 21, and a banquet at the Portage Hotel for Tuesday evening, Oct. 22, at which prominent speakers will be heard. Interesting inspection trips are being planned to include the plants of the Firestone Tire & Rubber Company, the Goodyear Tire & Rubber Company, the B. F. Goodrich Company, and several others.

News of Canada

Gatineau delivers 50,000 hp. more to Ontario — Coal production — C.A.S.E. reorganizing — Back River project progressing— New development in British Columbia

THE International Hydro-Electric System, through its subsidiary, the Gatineau Power Company, recently commenced delivery of an additional 50,000 hp. of electric energy to the Hydro-Electric Power Commission of Ontario. This quantity of power increases to 130,000 hp. the total energy now being delivered by the Gatineau Power Company to the commission. About Oct. 15 the Gatineau Power Company will deliver a further 20,000 hp. to the commission, raising the total deliveries to 150,000 hp. This 20,000 hp. is part of the additional quantity scheduled under contract for delivery Oct. 1, 1930, the delivery date being thus anticipated by nearly a year.

The contract under which these additional quantities of electric energy are now being delivered is one of two contracts which the Gatineau Power Company has with the Hydro-Electric Power Commission of Ontario and is one of the largest power contracts ever signed. It runs for thirty years from Oct. 1, 1928—when the company commenced delivery of 80,000 hp.—and calls for annually increasing quantities of power until Oct. 1, 1931, when the fixed maximum demand will be 260,000 hp. Under the second contract an additional 100,000 hp. is reserved for the commission, which agrees to take at least 60,000 hp. This power is to be taken in minimum annual increments of 6,000 hp. for ten years beginning Oct. 1, 1928. The commission will take the balance of the 100,000 hp. during the ten years as needed.

Coal Production

Coal production in Canada for the second quarter of 1929 amounted to 4,153,904 tons, while imports in the same period totaled 4,056,953 tons, of which amount 3,842,992 tons had their origin in the United States, the Dominion Bureau of Statistics reports. The figures show an increase in production of ten per cent, and an increase in imports of 15 per cent, over the corresponding months in 1928. A feature of the report is the purchase of 2,646 tons from Russia.

C.A.S.E. Reorganizes

That the campaign being conducted to re-establish the Canadian Association of Stationary Engineers as the dominant body in the operating field of the Dominion—a status it enjoyed for many years after its organization in 1887—is bearing fruit seems evident from the present activity of Ottawa Lodge, No. 6, of which Capt. J. E. Cross is secretary. Reinstated recently with such experienced organizers as Charles Berry, J. B. Mulligan, H. B. Devine, L. D'Aoust

and Captain Cross among its officers, C.A.S.E. No. 6 is certain to be heard more of in the months to come.

Back River Project

Machinery, generators and waterwheels are being installed in the power house of Montreal Island Power Company's new development on the Back River, near Montreal, and it is expected that initial production from two units will be effected by Nov. 1. These units are being installed with a preliminary continuous output of 42,000 hp., with machinery installation of about 72,000 hp. The ultimate continuous output, however, is estimated at 65,000 hp. and the ultimate machinery installation will be about 120,000 hp. On account of the decrease in the head during flood times it is necessary to install sufficient machinery to carry the continuous output under the reduced head.

Development in B. C.

Under present plans, buildings and substructures looking to an ultimate development of 30,000 hp. will be erected by the Northern British Columbia Power Company. The power house will be situated about 750 ft. below the dam and connected to it by steel penstocks. The power house site, which is 15 miles from Port Essington, is about 500 ft. above the confluence of the Falls River with the Ecstall River. For the present, power will be developed under an initial head of about 200 feet. This development will probably be accomplished in four units, each unit to be put in as the load warrants. The dam at the crest of the falls also will be built on the unit basis so that it may be increased in height from time to time as found necessary.

Foshay Buys Utah Company to Serve Boulder Dam

Announcement of the purchase of the controlling interest in the Dixie Power Company by the W. B. Foshay Company, of Minneapolis, Minn., was made recently. The Dixie Power Company serves seventeen communities in Washington and Iron counties, Utah. The estimated value of the Dixie Power Company's holdings is $1,500,000. Four hydro-electric generating plants and one Diesel engine plant, and approximately 30 miles of transmission lines were included in the deal.

It is stated that the acquiring of control of the Dixie Power Company by the Foshay interests is one of the final steps in a plan to gain control of all power plants in the vicinity of the proposed Boulder dam, with a view to furnishing the government with power during the construction of the dam. Power lines of the holding company in Arizona are only about 90 miles from the Dixie company's lines, and it is expected that an interconnection will be established. Installation of a new generating plant in southern Utah also is said to be contemplated by the new owners.

Coming Conventions

American Institute of Electrical Engineers. District meeting at Chicago, Ill., Dec. 2-4. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Third National Fuels Meeting at the Bellevue-Stratford Hotel, Philadelphia, Pa., Oct. 7-10.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Obituary

Henry Fisher, Redlands, Calif., capitalist who financed the construction of the first three-phase, long-distance transmission hydro-electric plant in the United States, died suddenly Sept. 6 at Santa Barbara. He ws 86 years of age. His death was due to advanced age and a heart ailment.

Mr. Fisher's business career, which included the organization of the Redlands Street Railway and the San Bernardino Valley Traction Company, began at Oil City, Pa., in 1864. He organized the Fisher Oil Company in the early years of the petroleum industry and was one of the originators of the pipeline method of oil transportation.

In 1893 Mr. Fisher moved his home to Redlands and became identified prominently with financial affairs of the San Bernardino Valley. He became president of the Redlands Electric Light & Power Company, organized by Henry H. Sinclair, and made possible the construction in Mill Creek Canyon of the first three-phase hydro-electric plant ever built in the United States. This organization was the parent concern of the Southern California Edison Company. Mr. Fisher continued his activities in the electrical industry of the West for many years. He was a director of the Southern California Edison Company until his retirement eight years ago, when his place on the Edison Company board was taken by his son, John H. Fisher.

Personals

H. G. Venemann has resigned his position as sales engineer with the Frick Company at Pittsburgh, Pa., to become head of refrigeration at Purdue University, Lafayette, Ind. Professor Venemann has been actively engaged in commercial refrigeration since he made exhaustive tests on the absorption machine at Harvard University in 1909. At Purdue he succeeds the late Prof. E. F. Burton, who was killed in an automobile accident last October.

Preston S. Arkwright, president of the Georgia Power Company, was elected president of the Association of Edison Illuminating Companies at the recent convention held in Quebec.

Colonel William Kelly, an internationally known engineer and authority on water power development, has been elected vice-president and general manager of the Buffalo, Niagara & Eastern Power Corporation. Colonel Kelly formerly served as chief engineer of the Federal Power Commission.

J. I. Boulian, who is on the staff of the Power Corporation of Canada, has been transferred by that company from the Riviere des Prairies power development to construction work at Stewart, B. C.

C. P. Dunn, who was formerly chief engineer of the Portland Electric Power Company, Portland, Ore., is now chief engineer of the Alcoa Power Company, Arvida, Quebec.

H. C. Jenkinson, formerly with the American District Steam Company at Tonawanda, N. Y., has joined the staff of the Alcoa Power Company at Arvida, Quebec.

Norman J. Gould, president of Gould Pumps, Inc., has recently been selected by the National Association of Farm Equipment Manufacturers as its representative on the committee on the relations of electricity to agriculture.

Eugene Holcomb, Consumers Power Company, Jackson, Mich., has been appointed chairman of the rural electric service comittee of the N.E.L.A.

Harold B. Smith, president of the American Institute of Electrical Engineers, was the principal speaker at a meeting of the Utah section in Salt Lake City on the evening of Sept. 9. Mr. Smith discussed recent transformer design, including one perfected to handle more than 1,000,000 volts. Preceding his address, Mr. Smith was the guest of honor at a dinner given by members of the Utah section.

Business Notes

McClave-Brooks Company, Scranton, Pa., announces the appointment of Frederick D. Rogers, 141 Milk St., Boston, Mass., as its representative for Massachusetts, Rhode Island and parts of Connecticut. Mr. Rogers formerly represented the Taylor Stoker Company. Other representatives appointed are: Rolf S. Julsrud, 3008 Pike Ave., Birmingham, Ala.; D. H. Hull, 1686 Lawrence St., Memphis, Tenn.; J. H. Kerfoot, 1912 Broad St., Nashville, Tenn.; Mill Supply Company, New Bern, N. C.; Wayne Belting & Supply Company, 132 East Columbus St., Fort Wayne, Ind.; Commonwealth Electric Company, 417 Broadway, St. Paul Minn.; Frank A. Simonds & Son, 310 Peninsular Building, Grand Rapids, Mich.; William F. Devendorf & Company, 70 Exchange St., Rochester, N. Y.; A. J. Faulder, 127 Wolcott Ave., Syracuse, N. Y.

Square D Company, of Detroit, Mich., manufacturer of electrical control equipment, acted as host to the western section of the International Association of Electrical Inspectors on the last day of its convention in Detroit some time ago. The entire visiting party was conducted on a tour of inspection through the Square D plant.

Cooling & Air Conditioning Corporation, 11 W. 42nd St., New York, N. Y., announces that W. H. Doron, formerly sales engineer in the ice machine department of the De La Vergne Machine Company, has entered its organization as sales engineer specializing in the application of air-conditioning equipment to industrial processes.

H. D. Conkey & Company, Mendota, Ill., are building an addition to their plant which will double its capacity. The addition is to be used for the fabrication of materials only, and will be equipped with the most modern tools for steel fabrication. This organization also announces the fact that the Cleveland Tool & Supply Company, Cleveland, Ohio is sales representative for its overhead traveling crane equipment in the Cleveland district.

Pennsylvania Pump & Compressor Company, Easton, Pa., announces the appointment of Joseph W. Eshelman as representative in the Birmingham, Ala. district. Mr. Eshelman's address is the American Traders' Bank Building, Birmingham.

Linde Air Products Company of New York City has opened a new oxygen plant at 1628 Cascade St., Erie, Pa. J. J. McKeen has been appointed superintendent of this plant.

Wagner Electric Corporation announces the opening of a new branch sales office at 734 Allen Bldg., Dallas, Texas, to cover the entire state of Texas and parts of Louisiana and Arkansas. Alfred B. Emrick, formerly manager of the Pittsburgh office, has been placed in charge. James G. Pattillo will succeed Mr. Emrick as manager of the Pittsburgh branch office.

Sullivan Machinery Company of Chicago announces the removal of its branch office and warehouse at Huntington, W. Va., from 736 Third Ave., to larger quarters at 702-704 Eighth Ave.

Trade Catalogs

Lubrication — "A picture story of Farval," is the title of a booklet recently published by Lubrication Devices Inc., Battle Creek, Mich. This booklet contains a large number of illustrations showing the use of the Farval centralized system of lubrication in various industrial plants.

Nickel Cast Iron — The International Nickel Company, Inc., New York City, has issued two bulletins, 201-A and 207, dealing with the desired improvements in cast iron and the manner in which these have been obtained by adding nickel, and nickel and chromium, to the iron.

Ammeters—Ammeters and milli-ammeters of the thermocouple type are described in a new issue of bulletin 810, distributed by the Roller-Smith Company, New York City. Specifications of the various models are included in the pamphlet.

Mechanical Transmission—A new catalog on "Cog-Belt" drives has recently been published by the Dayton Rubber Manufacturing Company, Dayton, Ohio. This catalog not only contains complete description of this type of drive, together with many photographs of actual operation, but also contains the complete tables in standardized form for choosing the correct drive and pulley without calculations for various applications.

Boilers—The Combustion Engineering Corporation, New York City, has just published a folder entitled "Building a Better Box Header Boiler." This folder describes and illustrates the single-seam construction which the Combustion Engineering Corporation has recently developed for its box header boilers in both the Heine and the Walsh-Weidner types.

Diesel Engines—An attractive 24-page catalog describing a new line of vertical Diesel Engines has been placed in the mail by the Buckeye Machine Company, of Lima, Ohio. This catalog contains a complete description of the various mechanical features of this type of Diesel engine, and illustrations of many installations.

Engine Indicators—The Bacharach Industrial Instrument Company, of Pittsburgh, Pa., has recently published three bulletins describing its Maihak type of engine indicators. Bulletin No. 1262 describes engine indicators for speeds up to 2,200 r.p.m. and pressures up to 5,000 lb. Bulletin No. 1263 describes indicators for Diesel, gas and steam engines, ammonia compressors and pumps, and Bulletin No. 1264 describes this type of indicator with a power integrator.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.10 @ $2.35
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.20 @ 1.60
Steam	Pittsburgh	1.40 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.65@$2.7
Barley	New York	1.40@ 1.

FUEL OIL

New York—Sept. 26, f.o.b., Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Sept. 23, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.5456 per bbl. or 42 gal.; 26@28 deg., $1.5956 per bbl.; 28@30 deg., $1.6456 per bbl.; 30@32 deg., $1.6956 per bbl.; 32@36 deg., gas oil, 4.526c. per gal.; 38@40 deg., distillate, 5.73c.

Pittsburgh—Sept. 17, f.o.b. local refinery, 30@34 deg., fuel oil, 4.125@4.25c. per gal.; 36@40 deg., 4.25@4.5c. per gal.

Philadelphia—Sept. 23, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Sept. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—Sept. 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70@75c. per bbl.; 26@30 deg., 95c.@$1.00 per bbl.; 30@32 deg., $1.10 per bbl.

Boston—Sept. 23, tank-car lots, f.o.b., 12@14 deg., Baumé, 4.45c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—Sept. 14, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Hollister—National Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, will build a 1 story cold storage plant here. Estimated cost $200,000. Private plans. Work will be done by day labor.

Calif., Lodi—City, J. F. Blakely, Clk., will receive bids until Oct. 7 for making test excavations for the construction of a hydro-electric development on Mokelumne River above Lancha Plant. L. F. Barzellotti is city engineer.

Conn., Bristol—New Departure Mfg. Co., 269 Main St., awarded contract for the construction of a substation and high tension switchhouse, $40,000; also five 1 and 2 story substations to Temple & Crane Inc., 80 Federal St., Boston, Mass.

Conn., East Hartford (br. Hartford)—Pratt & Whitney Aircraft Co., F. B. Rentschler, Pres., 450 Capital Ave., Hartford, is receiving bids for a 54 x 128 ft. power house here. Estimated cost $40,000. A. Kahn, Inc., 1004 Marquette Bldg., Detroit, Mich., is architect.

Fla., Lake Wales — Southern Utilities Co., Jacksonville, will build a 1 story, 80 x 160 ft. ice plant here. Estimated cost $200,000. Work will be done by day labor.

Fla., Mountain Lake—Mountain Lakes Corp., plans the construction of a waterworks system including new wells, pump house, mains, etc. Weideman & Singleton, Candler Bldg., Atlanta, Ga., are engineers.

Ill., Riverside — Village, will receive bids until Oct. 14 for waterworks improvements, including well, pumping station, etc. Estimated cost $100,000. Marr, Green & Co., 400 North Michigan Ave., Chicago, are engineers.

Mass., Chatham—Bd. of Selectmen, is receiving bids for the construction of a water system and pumping station. H. Lymonds, 70 State St., Boston, is engineer.

Mich., Detroit—Dept. of Water Supply, D. C. Grobbel, Acting Secy., 735 Randolph St., received lowest bid for the construction of power plant foundations for Springwells station, from E. H. Latham, 447 Neilson Ave., Columbus, O., $588,477.

Mich., Flint — Consumers Power Co., West Michigan Ave., Jackson, awarded contract for the construction of an electric sub-station here, to Stevens & Wood, Consumers Power Bldg., Jackson. Estimated cost $200,000.

Miss., Meridian—Mississippi State Hospital, c/o W. C. Trotter, Secy., Mississippi State Building Comn., Jackson, will receive bids until Oct. 3 for the construction of a hospital, including 85 x 122 ft. service building, 62 x 138 ft. power house, stack, 125 ft. high, steam conduit, etc., here. Estimated cost $225,000. R. C. Springer, Rosenbaum Bldg., Meridian, is architect.

N. J., Hillside — Dept. of Institutions & Agencies, State Office Bldg., Trenton, received lowest bid for the construction of a power house at New Jersey State Hospital here from Delaware Form Co., 1001 Chestnut St., Philadelphia, Pa. $60,558.

N. Y., New York—Dept. of Parks, received lowest bid for the construction of a power house and service building for American Museum of Natural History, Columbus Ave. and 77th St., from M. F. Kelly Building Corp., Grand Central Terminal Bldg. $812,500.

O., Cincinnati—Thomas Emery's Sons Inc., 114 East 4th St., awarded contract for a 43 story hotel and office building at 5th and Vine Sts. to Starrett Building Co., 8 South Dearborn St., Chicago, Ill. Estimated cost $14,000,000.

O., Cleveland—Industrial Rayon Co., H. Rivitz, Pres., 9801 Walfofd Ave., awarded contract for the construction of a 30 x 50 ft. boiler house to G. A. Rutherford Co., 2725 Prospect Ave. Estimated cost $40,000.

Pa., Pittsburgh—Corliss Coal Co., L. Sasso, Mgr., 200 Corliss St., awarded contract for extension to coal handling plant including new shaking screens, 4 bins, belt conveyor, etc., to Pittsburgh Engineering Foundry & Construction Co., 39th St. and A. V. R.R.

Va., Boydton—R. E. Scott, Mutual Bldg., Richmond, is acting as trustee in acquiring land for the construction of a hydro-electric plant on the Roanoke River near here. Estimated cost $600,000. New York interests are reported to be financing project.

B. C., Vancouver — British Columbia Power Corp. and British Columbia Electric Railway Co. Ltd., 425 Carrall St., plan the construction of a dam and hydro-electric plant, 70,000 hp. capacity on Campbell River, Vancouver Island. Estimated cost $19,000,000. E. E. Carpenter, is engineer.

Ont., Walkerton—Walkerton Electric Light & Power Co., plans to rebuild power dam destroyed by flood. $50,000.

Sask., Weyburn—City Council, plans to expend $65,000 for the construction of a new 750 kw. unit for municipal power plant.

Que., La Sarre — La Cie de Pouroirde La Sarre, plans the construction of a power plant.

Equipment Wanted

Air Compressors—New Zealand Government Railways, Auckland, N. Z., will receive bids until Oct. 28 for three air compressors with piston displacement, 100 cu.ft., 100 lbs. pressure, 350 r.p.m.; five air compressors, 75 ft., 100 lb. pressure, 275 to 300 r.p.m.; one air compressor, 50 ft., 100 lb. pressure, 275 to 300 r.p.m. all with motors, belts and attachments.

Air Compressor, Governor, etc.—Dept. of City Transit, C. E. Myers, Dir., City Hall Annex, Philadelphia, Pa., will receive bids until Oct. 4 for plumbing and sewage ejectors, including air compressor, motor governor, safety switch, air receiver, auxiliary pump, etc., in connection with Broad St. subway.

Boilers—Bureau of Yards & Docks, Washington, D. C., will receive bids until Oct. 9 for furnishing and installing two 150 hp. hand fired water boilers, including foundations boiler settings and accessories.

Boilers, Coal and Ash Handling Equipment, etc.—Wayne County, c/o County Road Comn., Barlum Bldg., Detroit, Mich., will receive bids until Oct. 11 for boilers, coal and ash handling equipment, etc., for proposed power plant and heating tunnels in connection with Wayne county airport development. Estimated cost $60,000.

Compressors, Motors, Switchboard, etc. — Ophuls & Hill, Inc., 112 West 42nd St., New York, N. Y., Engrs., receiving bids for four new ammonia compressors, two d.c. compressors: one 150, two 100 and one 75 hp. synchronous motors, two transformer vaults, 300 kw. capacity each, two 110 ft. steel and tube condensers, two 800 g.p.m. water pumps, switchboard, etc., for proposed alterations to power plant for Union Storage Co., 2nd and Liberty Sts., Pittsburgh, Pa. This corrects report in Sept. 24 issue.

Engine and Generator—E. Kirk, 8 Church St., Woburn, Mass., is in the market for a 100 hp. engine and generator.

Generators, Pumps, etc.—Quartermaster Supply Office, Fort Mason, San Francisco, Calif., will receive bids until Oct. 5 for 200 kw. electric generators, d.c., 100 to 125 v.; lubricating oil, vertical duplex piston type pumps, 14 x 14 x 18 in.; two liners for Worthington Vertical Blake Knowles (simplex type) main feed pumps.

Mechanical Unloaders, Motors, Etc.—North-Western Terminal Co., 226 Water St., Evansville, Ind., is receiving bids for mechanical unloaders, covered belt conveyors, hoppers, chutes, motors, etc. for proposed coal handling and distribution plant. Estimated cost $100,000.

Pumps, Motors, etc.—City of Griffin, Ga., R. G. Hicklin, Mgr., Municipal Dpt., will receive bids until Oct. 10 for 1,400, 2,100 and 2,800 g.p.m. raw water pumps, 500, 1,400, 2,100 and 2,800 g.p.m. clear water pumps, 15, 100, two 150, two 200 and 300 hp. synchronous motors, 2ph., 60 cycle, 550 v. for proposed waterworks.

Pumps, Motors, etc.—Improvement Dist. 1, Wynne, Ark., two centrifugal pumps, two electric motors, etc., for proposed sewage disposal plant. Estimated cost $55,000.

Pumps, Switchboard, etc.—A. L. Flint, General Purchasing Officer of Panama Canal, Washington, D. C., will receive bids until Oct. 11 for sump pumps, switchboard, etc.

Stokers, Conveyors, etc. — Culver Military School, Culver, Ind., coal stokers, ash conveyors, coal larries, water softeners and purifiers, etc., for proposed boiler house. Estimated cost $150,000.

Transformers, Circuits and Switching Apparatus—Western Counties Electric Co. Ltd., Brantford, Ont., plans to purchase three 1,000 kw. transformers and two new circuits and switching apparatus for proposed sub-station on Water St.

Transformers, Circuit Breakers, Lightning Arresters, etc.—Bureau of Reclamation, Denver, Colo., will receive bids until Oct. 24, for three 3,333 kva., 33,000 to 66,000/132,000 v. single phase transformers; three 33,000 v. wound type oil filled current transformers; one 13,000 v. dry type current transformer; one 132,000 v., 600 amp. and one 37,000 v., 300 amp. oil circuit breakers; one 132,000 v. lightning arrester; seven 132,000 v., 600 amp., nine 33,000 v., 300 amp. disconnecting switches; two 33,000 v. fused disconnecting switches; three 132,000 v. 400 amp. suspension type choke coils; one switchboard and auxiliary apparatus for 132 kv. substation at Minidoka power plant, Minidoka project, Idaho.

Industrial Projects

Calif., San Bruno—Heintz & Kaufman, 219 Natoma St., San Francisco, is having plans prepared for the construction of first unit of factory for the manufacture of radio equipment. Estimated cost $50,000. A. E. Neumarkel, 544 Market St., San Francisco, is architect.

Calif., Alhambra—H. M. Hanshue, Western Air Express, 117 West 9th St., Los Angeles, plans the construction of an airplane factory, including machine shop equipment, etc., on Valley Blvd., here. Estimated cost $300,000.

Mich., Detroit—Mueller & Krecke, 1001 American Radiator Bldg., Archts., will receive bids about Oct. 11 for a 1 and 2 story, 65 x 120 ft. factory on Humboldt Ave. for Koestlin Tool & Die Co., 3601 Humboldt Ave. Estimated cost $50,000. Equipment will be required.

Mich., Lansing—Fisher Body Corp., General Motors Bldg., Detroit, is receiving bids for a 2 story addition to automobile body plant on Division St., here. Estimated cost $240,000. H. E. Beyster, 9-261 General Motors Bldg., Detroit, is engineer. Electric motors and equipment for handling and finishing automobile bodies will be required.

Mo., St. Louis—St. Louis Truck & Mfg. Co., 3200 North Hall St., awarded contract for a 1 story, 60 x 120 ft. factory at Railroad and Thatcher Ave. to Gillespie-Daly, International Bldg.

N. J., Hoboken—Bonanno Bros., 1827 Bergen Turnpike, North Bergen, manufacturers of steam shovels and cranes, will build a 1 story, 70 x 140 ft. assembly and distribution plant at Willow and Clinton Aves., here. Estimated cost $40,000. Private plans. Harnischfeger Sales Corp., 38th and National Ave., Milwaukee, Wis., lessee.

Mich., Pontiac—Thompson Aeronautical Corp., 820 Book Bldg., Detroit, is having plans prepared for the construction of hangar, office and shop buildings, including cenrtal power house at Municipal Airport, here. Estimated cost $100,000. Robert Wright Co. ,1002 Swetland Bldg., Cleveland, O., is engineer. Electric motors, and shop and engine testing equipment will be required.

N. J., Passaic—Lockwood Greene Inc., 100 East 42nd St., New York, N. Y., Archts. and Engrs., will receive bids about Oct. 15 for the construction of a 4 story factory here, for U. S. Rubber Co., 211 Passaic St. Estimated cost $1,000,000.

N. Y., Buffalo — Stewart Motor Corp., 93 Dewey Ave., will soon award contract for the construction of a 97 x 250 ft. factory. Estimated cost $60,000. North & Shelgren, Crosby Bldg., are architects.

N. Y., New York—Associated Linen Suppliers Laundry, 432 East 19th St., plans addition to laundry, boiler and engine room, at 429 East 18th St. M. Klein, 65 Court St., Brooklyn, is architect.

O., Cleveland—Osborn Mfg. Co., 5401 Hamilton Ave., is receiving bids for a 4 story, 49 x 106 ft. factory for the manufacture of brushes and foundry equipment. Estimated cost $200,000. Austin Co., 16112 Euclid Ave., is architect.

O., East Liverpool—Hall China Co., plans the construction of a pottery on Harvey Ave. Estimated cost $500,000. Architect and engineer not announced.

O., Tiffin—Sterling Grinding Wheel Co., is receiving bids for a 1 story factory. Estimated cost $50,000. G. S. Rider Co., Century Bldg., Cleveland, is architect.

Okla., Ardmore—Swift & Co., Packers and Exchange Ave., Chicago, Ill., is having plans prepared for the construction of a produce plant here. Estimated cost $150,000.

Tex., Dallas—Atlas Metal Works, 2601 Alamo St., has work under way on the construction of a 1 story, 200 x 210 ft. factory on Browder Rd. Estimated cost $150,000.

Wis., Wisconsin Rapids—Consolidated Water Power Paper Co. awarded contract for addition to paper mill including 53 x 112 ft. filter plant and 68 x 113 ft. finishing room to T. Utegaard, Wisconsin Rapids.

Ont., Oshawa—Skinner Mfg. Co. Ltd., Gananoque, awarded contract for the construction of a 1 story, 127 x 416 ft. automobile bumper factory here to Ferguson Contracting Co., Confederation Life Bldg., Toronto. Oil burning equipment, etc. will be required.